REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	MAY 2001	MASTER OF SCIENCE IN ENGINEERING THESIS

4. TITLE AND SUBTITLE

AIR POLLUTANT SOURCE ATTRIBUTION FOR SOUTHEAST TEXAS USING $^{14}C/^{12}C$ RATIOS

5. FUNDING NUMBERS

NA

6. AUTHOR(S)

CPT. KENNETH R. LEMIRE

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

AUTHOR
4411 SPICEWOOD SPRINGS RD # 2306
AUSTIN, TX 78759
(512) 689-4253

8. PERFORMING ORGANIZATION REPORT NUMBER

NA

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

DEPARTMENT OF CHEMICAL ENGINEERING
UNIVERSITY OF TEXAS AT AUSTIN

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

NA

11. SUPPLEMENTARY NOTES

NONE

12a. DISTRIBUTION / AVAILABILITY STATEMENT

A- "APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED"

12b. DISTRIBUTION CODE

NA

13. ABSTRACT *(Maximum 200 words)*

REFER TO DOCUMENT (PAGES iv AND v)

14. SUBJECT TERMS

OZONE / PARTICULATE MATTER / BIOGENIC EMISSIONS / RADIOCARBON (^{14}C) MEASUREMENTS

15. NUMBER OF PAGES

185

16. PRICE CODE

NA

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UNLIMITED

Air Pollutant Source Attribution for

Southeast Texas using $^{14}C/^{12}C$ ratios

by

Kenneth Robert Lemire, B.S.

Thesis

Presented to the Faculty of the Graduate School

of the University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Master of Science in Engineering

The University of Texas at Austin

May 2001

Air Pollutant Source Attribution for

Southeast Texas using $^{14}C/^{12}C$ ratios

APPROVED BY

SUPERVISING COMMITTEE:

David Allen

Gary Rochelle

Air Pollutant Source Attribution for

Southeast Texas using $^{14}C/^{12}C$ ratios

by

Kenneth Robert Lemire, M.S.E.

The University of Texas at Austin, 2001

SUPERVISOR: David T. Allen

Both ambient air samples for VOC analysis and particulate matter samples were collected in the greater Houston area in an attempt to assess the biogenic contribution to the formation of ground-level ozone and particulate matter through the use of radiocarbon measurements. This effort was just a small portion of the many experiments conducted as a part of the Texas Air Quality Study (TEXAQS) 2000. In particular, this set of samples was collected in the time frame of early August 2000 to mid September 2000, when the TEXAQS program was at its most intensive point, with the intention of utilizing the many other sources of supporting and collaborative data that were created in that time period.

Biogenic emissions play a substantial role as a source of particulate matter for two sampling sites in particular. The results from eleven samples, taken from a suburban site (Aldine) in northwest Houston and a rural site (Conroe) approximately thirty miles north of Houston, provide strong evidence of a significant fraction of the particulate matter collected being biogenic in

origin. Values reported from Aldine fall into two distinct ranges of 25-37% biogenic or 46-68% biogenic. One sample from Conroe, dated 13 August 2000, has a biogenic fraction of 72%.

All eleven samples were taken prior to a forest fire event that occurred during the TEXAQS period. Very little evidence was found for vegetative detritus as a source of organic carbon in any of the samples for which trace metal data are available. Little evidence of cooking emissions is seen in the trace metal analyses for two samples at Aldine (18 and 19 August), and only small contributions from cooking are expected for a 25 August sample.

Therefore, with the exception of accounting for the possibility of small amounts of young carbon (^{14}C) produced by cooking activity, the remainder of the particulate matter must be attributed to secondary organic aerosol at Aldine and Conroe on these dates, and a significant portion of that SOA must be biogenic in origin. VOC data do not indicate the presence of significant levels of isoprene at Aldine, suggesting conifer trees provide substantial biogenic emissions. In the case of Conroe, there were several occasions during the TEXAQS period when large isoprene concentrations were detected by aircraft, in isolated regions, north of Houston in the vicinity of the sampling site. Therefore, isoprene emissions and other emissions from deciduous vegetation may be a source of biogenic SOA in isolated areas north of Houston.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ILLUSTRATIONS

I INTRODUCTION

I.1 GENERAL

Two primary areas of concern with regard to poor air quality are the formation of ozone within the lower troposphere and the production of fine particulate matter (PM). Both pollutants are well documented as hazardous to human health, and widely regarded as extremely difficult to control. Many sources, both natural and man-made, contribute to the eventual appearance of ozone and PM. Complicated, and hard to predict, meteorology adds to the complexity. With the ultimate goal of adopting control strategies that will significantly reduce the amount of ozone and PM emitted to the atmosphere, tools such as regional photochemical (grid-based) modeling and trajectory, or plume-based, modeling are used to theorize the origin and transport of various pollutants. However, the models are limited by the current understanding of atmospheric science, especially the potential significance of biogenic (or natural) emissions compared to anthropogenic (or man-made) emissions.

I.2 OZONE

Ozone (O_3) is a highly reactive gas that is naturally formed at high altitude in the stratosphere by photochemical reactions involving molecular and atomic oxygen in the presence of high-intensity ultraviolet radiation. Its concentration in the upper atmosphere depends on both the altitude and latitude. Ozone there plays a beneficial role by absorbing ultraviolet radiation from the sun and thus protecting the life on earth from the destructive effects of such radiation. Unlike the "good" stratospheric ozone, there is also the "bad" ozone in the troposphere near the ground, which is damaging to plants and materials

and harmful to human health. Ozone is formed in polluted atmospheres as a result of a rather wide variety of photochemical reactions involving nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight.

The chemistry of tropospheric ozone formation is complex. The production of ozone from the photodissociation of NO_2 is illustrated by the following chemical reactions:

$$NO_2 + hv \rightarrow NO + O(^3P)$$

$$O(^3P) + O_2 \rightarrow O_3$$

$$O_3 + NO \rightarrow NO_2 + O_2$$

where hv represents the ultraviolet radiation.

Nitrogen dioxide (NO_2) is photodissociated into nitric oxide (NO) and an excited state of oxygen $O(^3P)$. The excited oxygen reacts with a diatomic oxygen molecule, producing ozone, O_3. However, this ozone reacts with NO, forming NO_2 and O_2 and closing the cycle. This simple cycle of reactions, resulting in formation but no net accumulation of ozone, establishes a photostationary state.

In the presence of VOCs, however, the above photostationary equilibrium is disturbed, because NO is converted into NO_2 by chemical reactions involving reactive hydrocarbons without consuming O_3. Reactions of VOCs and oxygen with OH radicals, which normally exist in the ambient atmosphere, yield RO_2 radicals, which then compete with ozone for the oxidation of NO and NO_2. There are hundreds of photochemical chain reactions involving the wide variety of reactive hydrocarbons that exist in a polluted atmosphere. The net result is the accumulation of ozone (Arya, 1999).

Figure I-1 Photostationary equilibrium

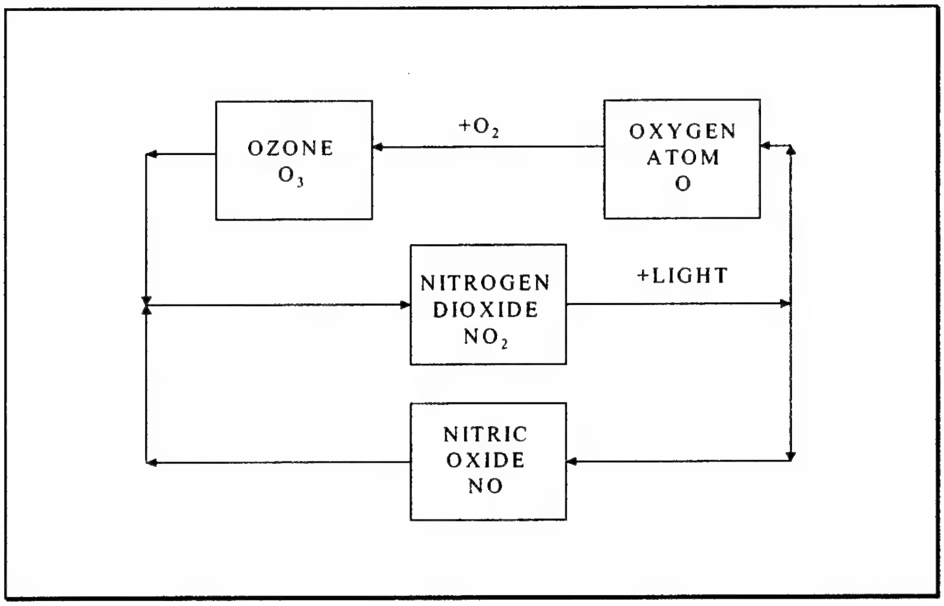
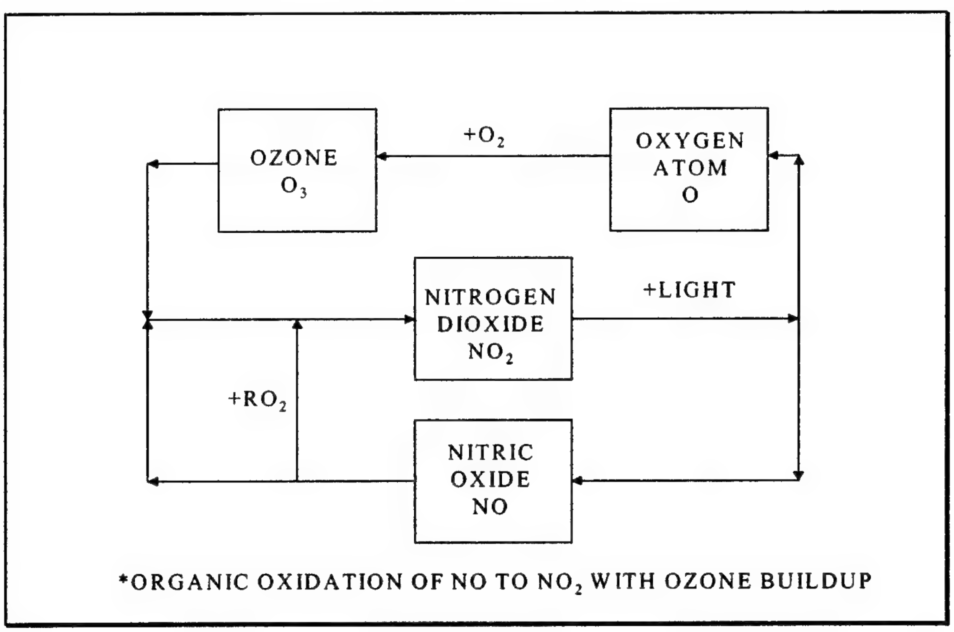


Figure I-2 Accumulation of ozone



Ozone is used as an indicator pollutant for photochemical oxidation products. The total mixture, frequently referred to as smog, causes eye irritation, lachrymation, and respiratory difficulties for people walking or working outdoors. Ozone has an acrid, biting odor that is a distinctive characteristic of photochemical smog. High concentrations of ozone and other photochemical oxidants are observed over most large cities and metropolitan areas during summer months. Harmful levels of ozone are also found to exist over large rural regions to which ozone gets transported from large urban and industrial areas. Thus, the tropospheric ozone is not merely an urban air pollution problem but also a regional problem, particularly for North America and Europe. It is by far the most persistent problem that has defied simple solutions based on current emissions control strategies (Arya, 1999).

I.3 PARTICULATE MATTER

Atmospheric particulates or aerosols include all liquid and solid particulates, except pure water, that exist in the atmosphere under normal conditions. Many of these are a result of direct emissions of particles from various natural and anthropogenic sources, while others form from the condensation of certain gases and vapors that are emitted into the atmosphere or are a result of chemical transformations. A full description of atmospheric aerosol requires specification of concentration, size distribution, chemical composition, phase (liquid or solid), morphology, and biological activity.

Sizes of atmospheric particles are expressed in several different ways. The most common measure is the actual diameter in micrometers (μm) for spherical particles. Nonspherical particles are frequently characterized in terms of the diameter of equivalent spherical particles that would have the same

volume, same mass, or same aerodynamic properties as the actual particles. On the basis of size, atmospheric particles are usually divided between two broad categories, fine particles and coarse particles. In view of the National Ambient Air Quality Standards (NAAQS) for particulate matter less than 10 μm in size (PM_{10}), 10 μm might be considered a reasonable choice for the boundary between coarse and fine particles. In practice, fine and coarse fractions are considered to be those collected by the fine and coarse fractions of a dichotomous particulate sampler, the fine stage having an upper cutoff point of about 2.5 μm (collecting particles smaller than 2.5 μm in aerodynamic diameter or $PM_{2.5}$) (Urone, 1986). Although the total suspended particulate matter (TSP) is relevant for visibility, soiling, and corrosion effects of particles, PM_{10} and $PM_{2.5}$ are considered more important for health effects. Also, particles larger than 10 μm fall out more readily through gravitational settling (Arya, 1999).

Based on their emission sources and mechanisms of formation, aerosols can be classified as primary and secondary aerosols. Primary aerosols are emitted in particulate form directly from sources and contain particles of all sizes. Secondary aerosols are particles produced in the atmosphere from gas-phase chemical reactions that generate condensable species. These are mainly sub-micron-sized fine particles (Seinfeld, 1986).

Major natural sources of atmospheric particulates are soil and rock debris, sea spray, wild fires, volcanic eruptions, and reactions between natural gaseous emissions. Anthropogenic sources of particulate matter can be divided into four broad categories: (1) fuel combustion and industrial processes, (2) industrial process particulate emissions, (3) nonindustrial emissions, and (4) transportation sources (Seinfeld, 1986). According to estimates by the U.S. Environmental Protection Agency (1982), nonindustrial emissions (roadway

dust from paved and unpaved roads, wind erosion from croplands, agricultural activities, etc.) of PM_{10} in the United States, on a mass basis, far exceed the particulate emissions from industrial and transportation sources. However, the impact of the dominant sources of nonindustrial emissions is limited to rural areas, because the emissions are mostly large particles that settle to the ground a short distance from the source. In urban areas, local emissions from industrial and transportation sources are more important, and in rural areas, local and regional industrial sources are significant contributors to the fine particulate matter fraction. The major source of nonindustrial, nontransportation particulate matter in urban areas is believed to be cooking activities (Arya, 1999).

Most of the particulates from transportation sources come from vehicle exhausts. These are generally smaller than 1 μm in diameter and are composed primarily of carbonaceous matter with some inorganics and metals. Primary particulate matter from other fuel combustion sources also fall into the category of fine particles, but may contain a large variety of chemical compounds, depending upon the type of fuel used and the type of combustion process involved (Arya, 1999).

I.4 BIOGENIC EMISSIONS

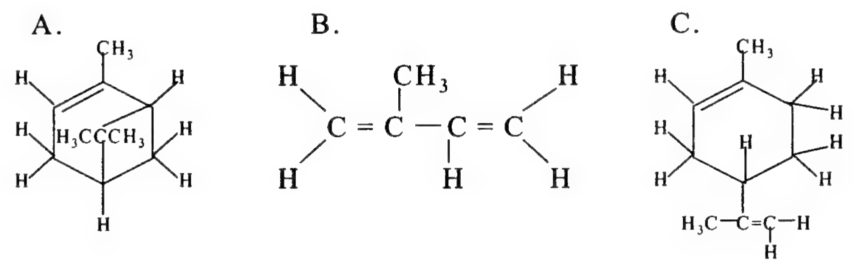
Vegetation is the most important natural source of atmospheric hydrocarbons. A compilation of organic compounds in the atmosphere lists a total of 367 different compounds that are released to the atmosphere from vegetative sources (Graedel, 1978). Averaged by land use over the continental United States, the natural emissions of reactive VOC (mainly isoprene and monoterpenes) are estimated to be approximately 1.4 times greater in total amount than anthropogenic sources of VOC. On a region-by-region basis,

however, this ratio likely varies considerably (Guenther, 2000). In Houston approximately 50% of all VOCs are of biogenic origin, and for the entire region of eastern Texas, that value may be as high as 80-90%. Other natural sources include microorganisms, forest fires, animal wastes, and volcanoes. One of the simplest organic compounds given off by plants is ethylene, C_2H_4. This compound is produced by a variety of plants and released to the atmosphere. Because of its double bond, ethylene is highly reactive with hydroxyl radical, HO·, and with oxidizing species in the atmosphere. Ethylene from vegetation sources should be considered as an active participant in atmospheric chemical processes.

Most of the hydrocarbons emitted by plants are either terpenes or isoprene (a five-carbon hemi-terpene), which constitute a large class of organic compounds found in essential oils. Most of the plants that produce terpenes belong to the family *Coniferae*, the family *Myrtaceace*, and the genus *Citrus*. One of the most common terpenes emitted by trees is α-pinene, a principle component of turpentine. The terpene limonene, found in citrus fruit and pine needles, is encountered in the atmosphere around these sources. Isoprene (2-methyl-1,3-butadiene), a hemiterpene, has been identified in the emissions from cottonwood, eucalyptus, oak, sweetgum, and white spruce trees. Other terpenes known to given off by trees include β-pinene, myrcene, ocimene, and α-terpinene.

As exemplified by the structures of α-pinene (A), isoprene (B), and limonene (C), shown in Figure I-3,

Figure I-3 Molecular structure of some example biogenic emissions



terpenes contain alkenyl (olefinic) bonds, usually two or more per molecule. Because of these and other structural features, terpenes are among the most reactive compounds in the atmosphere. The reaction of terpenes with hydroxyl radical is very rapid, and terprenes also react with other oxidizing agents in the atmosphere, particularly ozone. Turpentine, a common mixture of terpenes, has been widely used in paint because it reacts with atmospheric oxygen to form a peroxide, then a hard resin. It is likely that compounds such as α-pinene and isoprene undergo similar reactions in the atmosphere to form particulate matter (Manahan, 1991).

I.5 RADIOCARBON (^{14}C) MEASUREMENTS

The connection between biogenic emissions (a major source of highly reactive VOCs) and the formation of ground-level ozone and particulate matter is well established. Isoprene, for example, can act as a sink for NO, can contribute to sequestration of nitrogen (allowing long distance transport), and through oxidation products (ketones, aldehydes, carbon monoxide) can have an impact on ozone chemistry (Fehsenfeld, 1992). Secondary aerosols are created from the reaction of α-pinene with ozone. These products include diacids, dominant during summer conditions, and di-carbonyl and carbonyl-acids, more frequent during winter conditions (Kamens, 1999). However, a large amount of uncertainty remains concerning how little or much these particular emissions contribute to the overall control problem (models have been used, but significant uncertainties exist in the models). There is also substantial difficulty inherent in direct measurement of the emissions because they are very reactive, and the reaction products are hard to isolate.

Therefore, the first step toward evaluating the degree of influence this set of VOCs has within the atmospheric chemistry is to obtain accurate measurements of radiocarbon (^{14}C). ^{14}C is absent in fossil fuels due to decay with a half-life of 5730 years, yet present in living materials at measurable levels, $^{14}C/^{12}C \approx 1.2 \times 10^{-12}$ (Klouda, 1999). Once an air sample containing ozone or a filter sample with deposited particulate matter is collected, a process that determines the quantity of ^{14}C within the sample may provide essential information about the role that biogenic VOCs play as precursors to pollutants. When it is determined that a significant portion of an individual air sample consists of ^{14}C containing species, an extensive speciation that details exactly

what compounds are present can also be invaluable. Since most types of vegetation have a fairly unique emissions signature, with the use of meteorological data, a particular VOC might be backtracked to its source.

I.6 PREVIOUS ^{14}C MEASUREMENTS

In recent years, the National Institute of Standards and Technology (NIST) and the United States Environmental Protection Agency (EPA) have explored methods and analytical procedures to collect enough carbon from atmospheric non-methane VOC fractions to measure the ^{14}C composition. Some particular areas of study have included Azusa, CA, Houston, TX, and Nashville, TN. In all of this previous work, air samples were collected during the summer. In Azusa (1997) air was compressed into canisters on several days during the following periods: 1) 0600-0900 hours, 2) 1300-1600 hours, and 3) 1700-2000 hours. Three air samples were cryo-collected in Nashville (1995), nominally from 0730-1130 hours at a site 24 kilometers southeast of the city center in a rural area, and combined into two samples. A third composite sample was comprised of 12 32-liter compressed air samples collected atop the city center Polk Building representative of 1200 to 1800 hours. In Houston (1994) samples were collected at three sites: 1) a northern suburban/rural site (Aldine) (AM and PM), 2) an industrial site (Clinton) in the ship channel area (PM), and 3) the Sam Houston National Forest 80 kilometers north of Houston (PM) (Klouda, 1999).

In Azusa fossil VOC-C was dominant in the early morning while biogenic emissions increased significantly in the afternoon, consistent with high pollution events driven more by fossil fuel than by non-fossil related emissions. In Nashville the city center showed a higher biogenic fraction (37% ± 6%) than

at the rural site, counter to what one might expect. However, there was a possibility of an intrusion of clean background air or some other source of living carbon. The ship-channel site in Houston was entirely void of ^{14}C in contrast to the National Forest sample that shows a surprisingly low but significant biogenic fraction, 23% ± 8%. The largest percentage of biogenic VOCs observed, 55% ± 4%, were from the Houston suburban/rural site in the afternoon (Klouda, 1999).

For the regions studied, the results suggested that biogenic sources are not the major contributor to atmospheric VOCs. However, no conclusions were drawn as to whether or not even a small fraction of biogenic emissions, being extremely reactive, are significant to the atmospheric chemistry involved with the formation of ground-level ozone or particulate matter. Also, obtaining an accurate measurement of the ^{14}C contained within a given air sample can be extremely difficult due to the necessity of removing all atmospheric CO_2. The samples also have to endure many steps, creating opportunities for human error and uncertainty, within the process that eventually produces graphite for ^{14}C accelerator mass spectrometry measurement.

I.7 HOUSTON

The city of Houston, and its surrounding area, is a unique region to study for the formation and transport of pollutants. The location of Houston on the Gulf of Mexico subjects the metropolitan area to some unusual meteorology including drastically shifting wind patterns throughout the course of a single day. There are also a wide variety of sources in and around the city that are subjected to this almost daily land-sea breeze. Not only is there the highly industrialized complex known collectively as the Ship Channel directly off of

Galveston Bay, but there is also a significant amount of urban traffic and a fairly substantial biogenic source from forestland immediately to the north of the city.

Houston air quality has been investigated for quite some time. As previously mentioned in the Klouda ^{14}C-VOC experiments, even the biogenic contribution has been examined to some degree. However, newer, more accurate methods of sampling have since been developed that may or may not create a different perspective. Also, previous sampling involved only a few samples and did not include particulates.

I.8 RESEARCH GOALS

The primary goals of this work were:

1) to collect particulate and VOC samples suitable for ^{14}C analysis during the 2000 Texas Air Quality Study (TEXAQS),
2) to assemble sufficient data, collected by other investigators during TEXAQS, to predict the amount of ^{14}C present within the canister (VOC) and filter (PM) samples,
3) to compare predicted ^{14}C levels to actual results from a portion of the samples selected for ^{14}C measurement.

II METHODOLOGY

II.1 GENERAL

A set of samples was collected in the greater Houston area in an attempt to assess the biogenic contribution to the formation of ground-level ozone and particulate matter through the use of radiocarbon measurements. This effort was just a small portion of the many experiments conducted as a part of the Texas Air Quality Study (TEXAQS) 2000. In particular, this set of samples was collected in the time frame of early August 2000 to mid September 2000, when the TEXAQS program was at its most intensive point, with the intention of utilizing the many other sources of supporting and collaborative data that were created in that time period.

II.2 SITES

II.2.1 General

All the sites that were chosen for sampling were selected on the basis of unique ^{14}C signatures that were expected. The following basic signatures were desired: 1) clean background air off of the Gulf of Mexico, 2) heavy industrial, preferably in the vicinity of the Ship Channel, 3) urban traffic, 4) downwind of the urban core, including the Ship Channel, and perhaps most importantly, 5) heavy biogenic, more than likely to the north of the city. Balancing what is expected to be present in an air sample of the various sites with what is actually observed through sampling is essential to the eventual understanding and modeling of what is occurring within the atmosphere.

II.2.2 Galveston

Illustration II-1 Galveston regional map

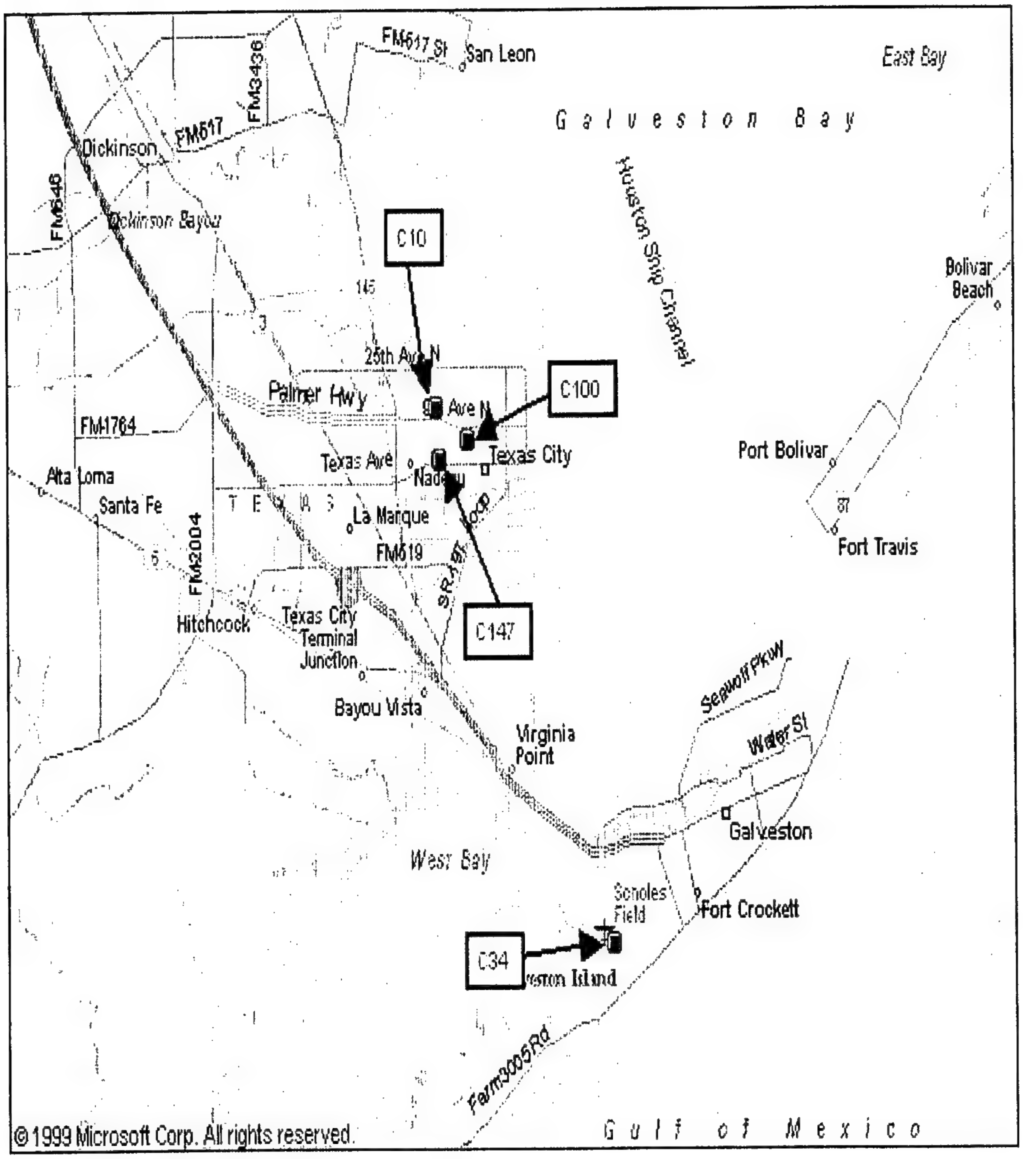


Illustration II-2 Galveston street map

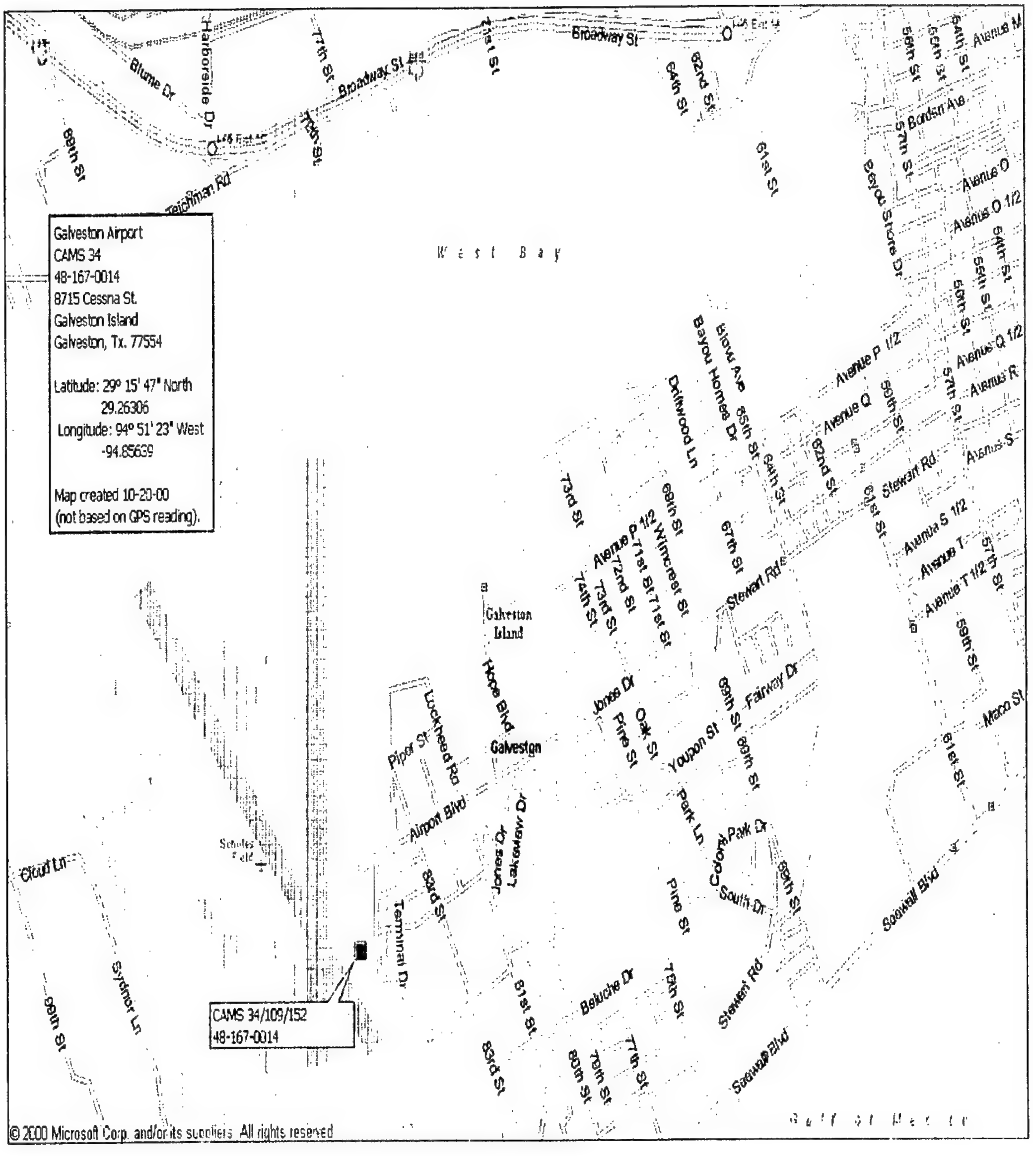
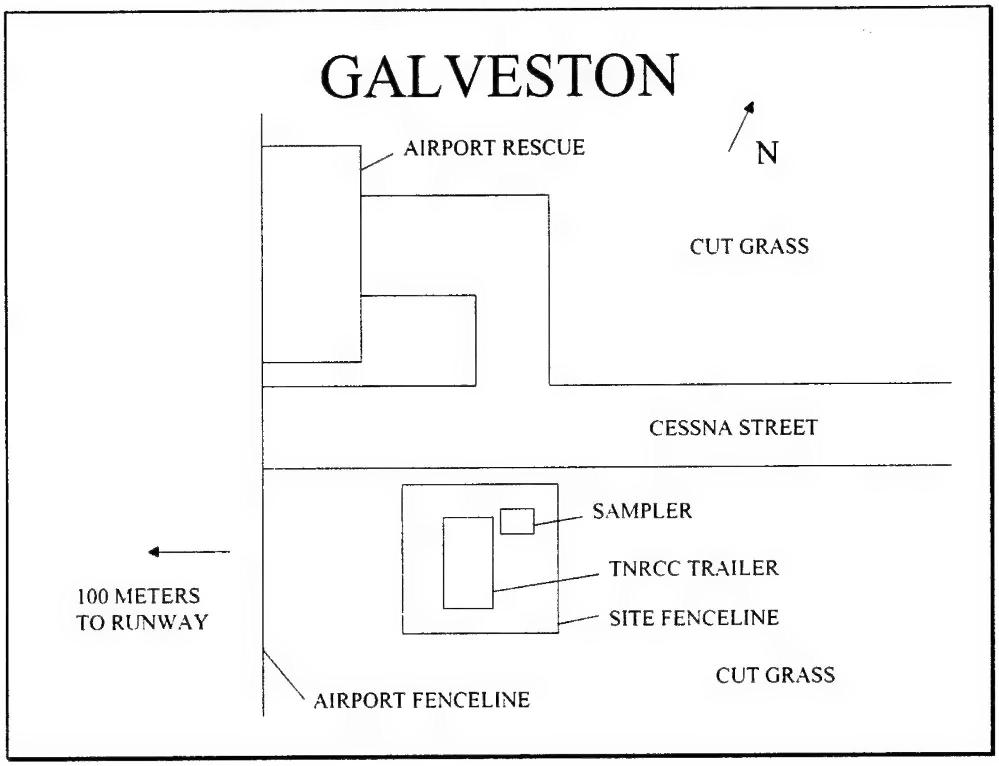


Illustration II-3 Galveston site map



The Galveston site was chosen for the possibility of sampling relatively "clean" air originating from the Gulf of Mexico. When the wind is blowing inland, this air can serve as a background fingerprint for what is present in the atmosphere prior to an air parcel passing over the Ship Channel and/or downtown Houston. When the wind shifts direction, which is not that uncommon, and blows out to sea, this site can be used as a downwind monitoring station for an air parcel that has passed over many of the urban sources. The site is located in an area with almost no vegetation (with the exception of grass), and the nearby airport has very little air traffic. Due to the lack of an elevated platform, sampling was conducted at the ground level.

II.2.3 HRM-3 (C603)

Illustration II-4 HRM-3 regional map

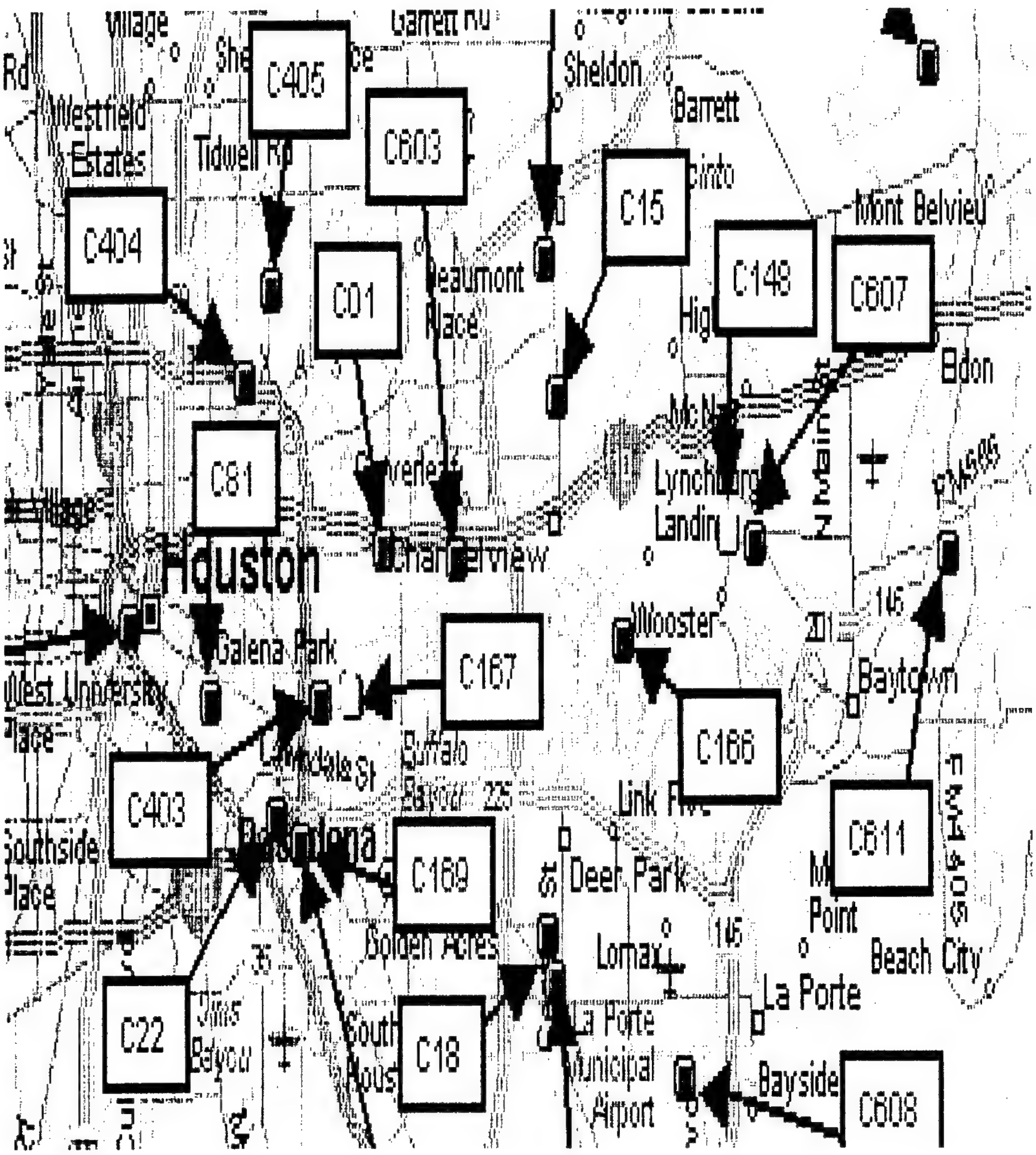


Illustration II-5 HRM-3 street map

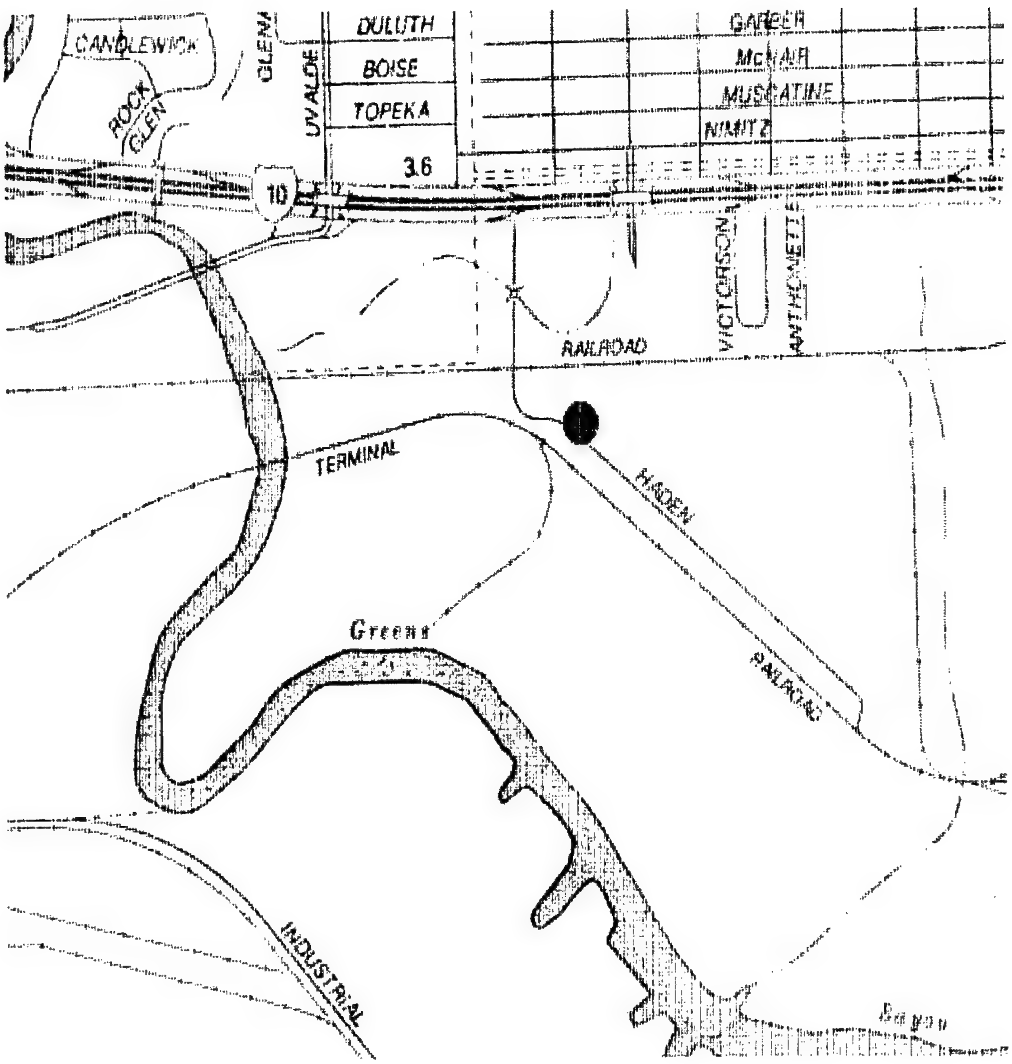
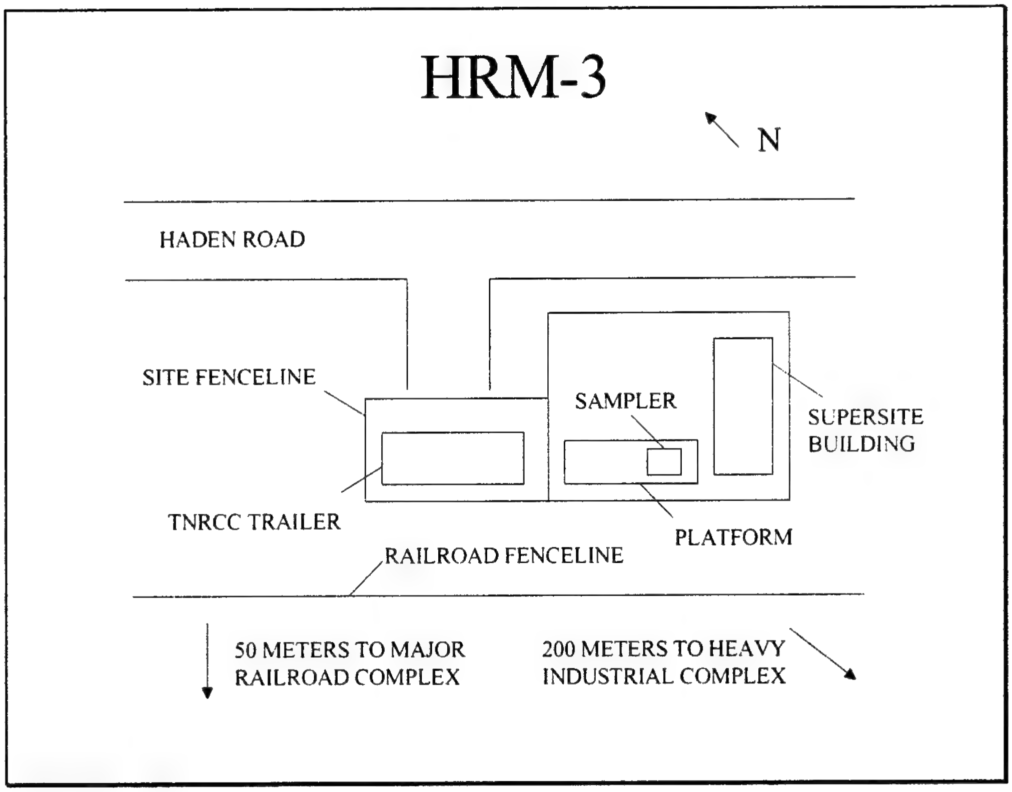


Illustration II-6 HRM-3 site map



A site within the immediate vicinity of the Houston Ship Channel was absolutely essential for gathering information about what is arguably the biggest area source of industrial emissions within the region. HRM-3 is just one of numerous monitoring stations that gathers data for this purpose. However, this particular site is also downwind (most of the time) of almost the entire heavy industrial complex. There are a very limited number of tall trees across the street to the northeast that may provide some local biogenic emissions. The railroad complex within the immediate vicinity has a significant amount of train activity. A temporary platform was constructed within the site fenceline for sampling at approximately ten feet above ground level.

II.2.4 Washburn Tunnel

Illustration II-7 Washburn Tunnel regional map

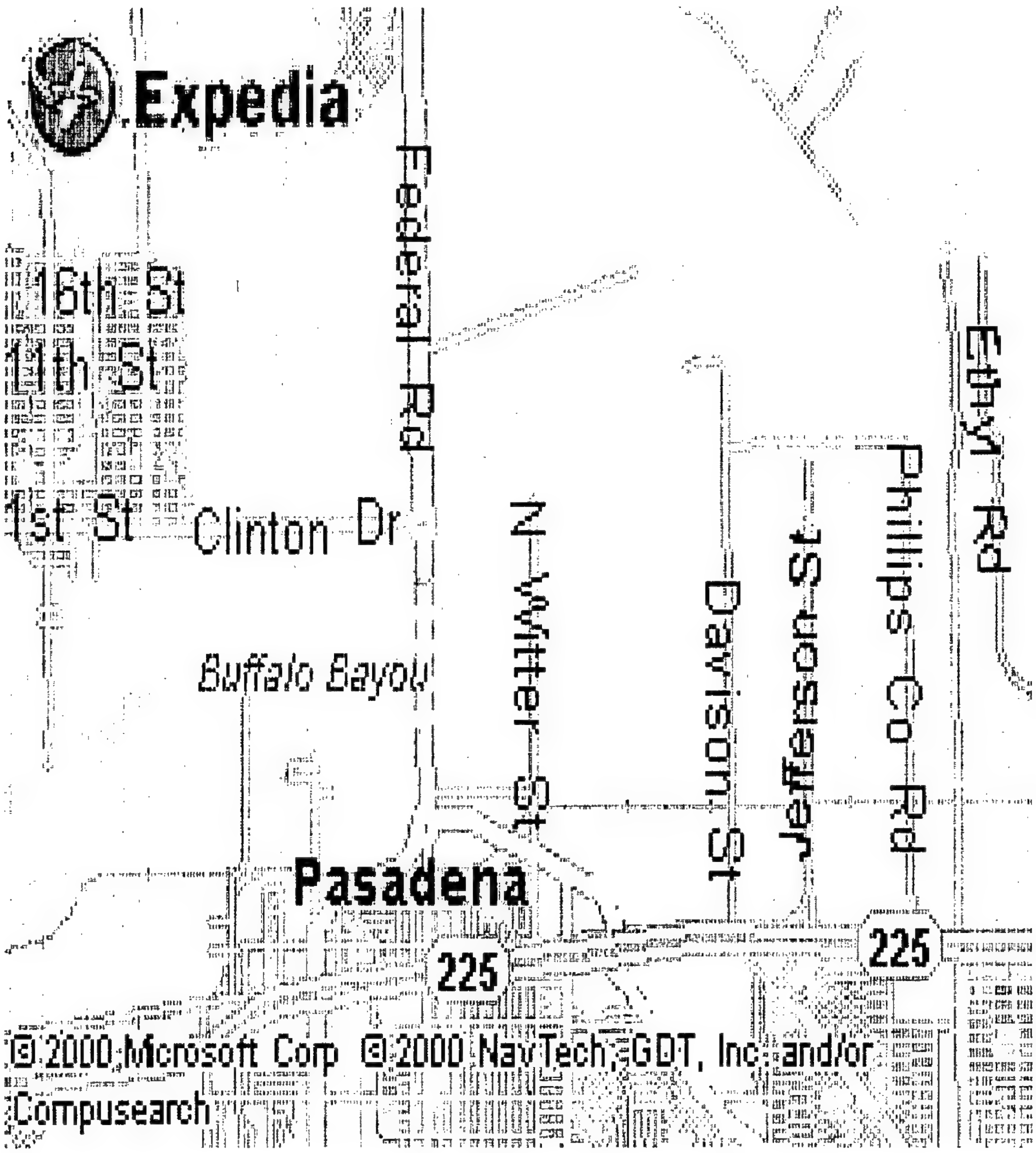


Illustration II-8 Washburn Tunnel street map

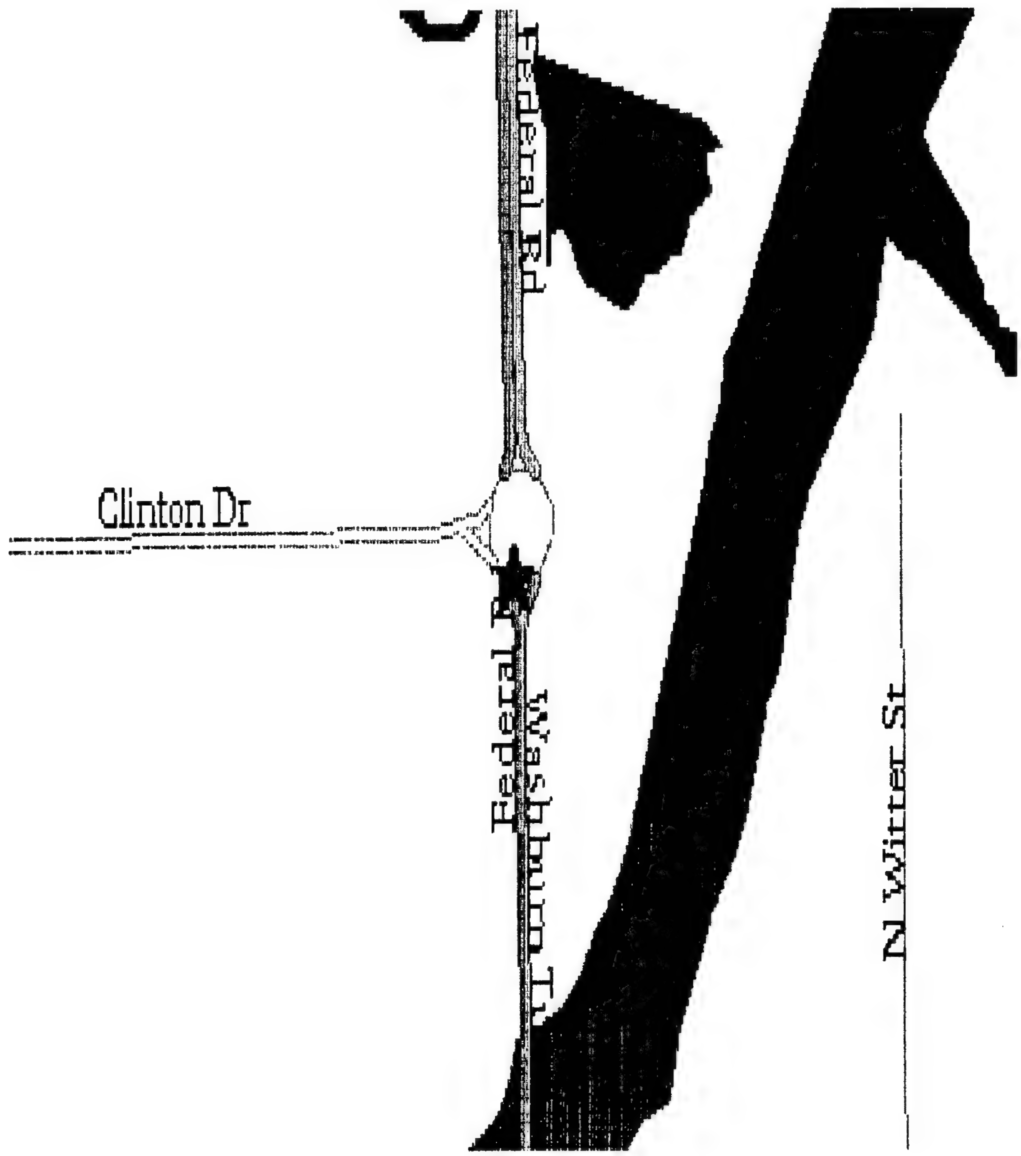
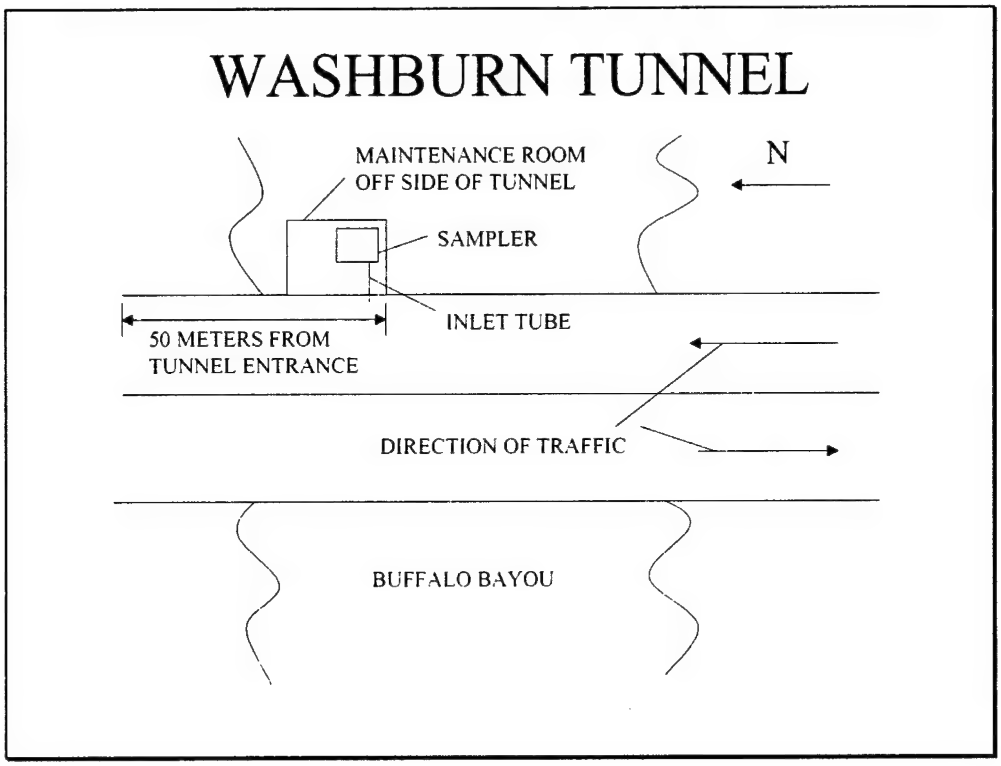


Illustration II-9 Washburn Tunnel site map



Within a major metropolitan area such as Houston, the daily contribution made to atmospheric chemistry by vehicular emissions is quite significant. An opportunity to sample at a site that would exhibit almost exclusively vehicular emissions became available about midway through the TEXAQS program. The 800 meter long Washburn Tunnel was sampled during rush hour traffic in an attempt to capture emission source data that are usually difficult to separate from other urban sources. The sampler in this particular case was placed on the floor of a maintenance room that had direct access to the inside of the tunnel. A teflon tube was used to collect air from the tunnel and deliver it to the inlet port on the sampler. Video cameras within the tunnel provide vehicular information.

II.2.5 Aldine (C08)

Illustration II-10 Aldine regional map

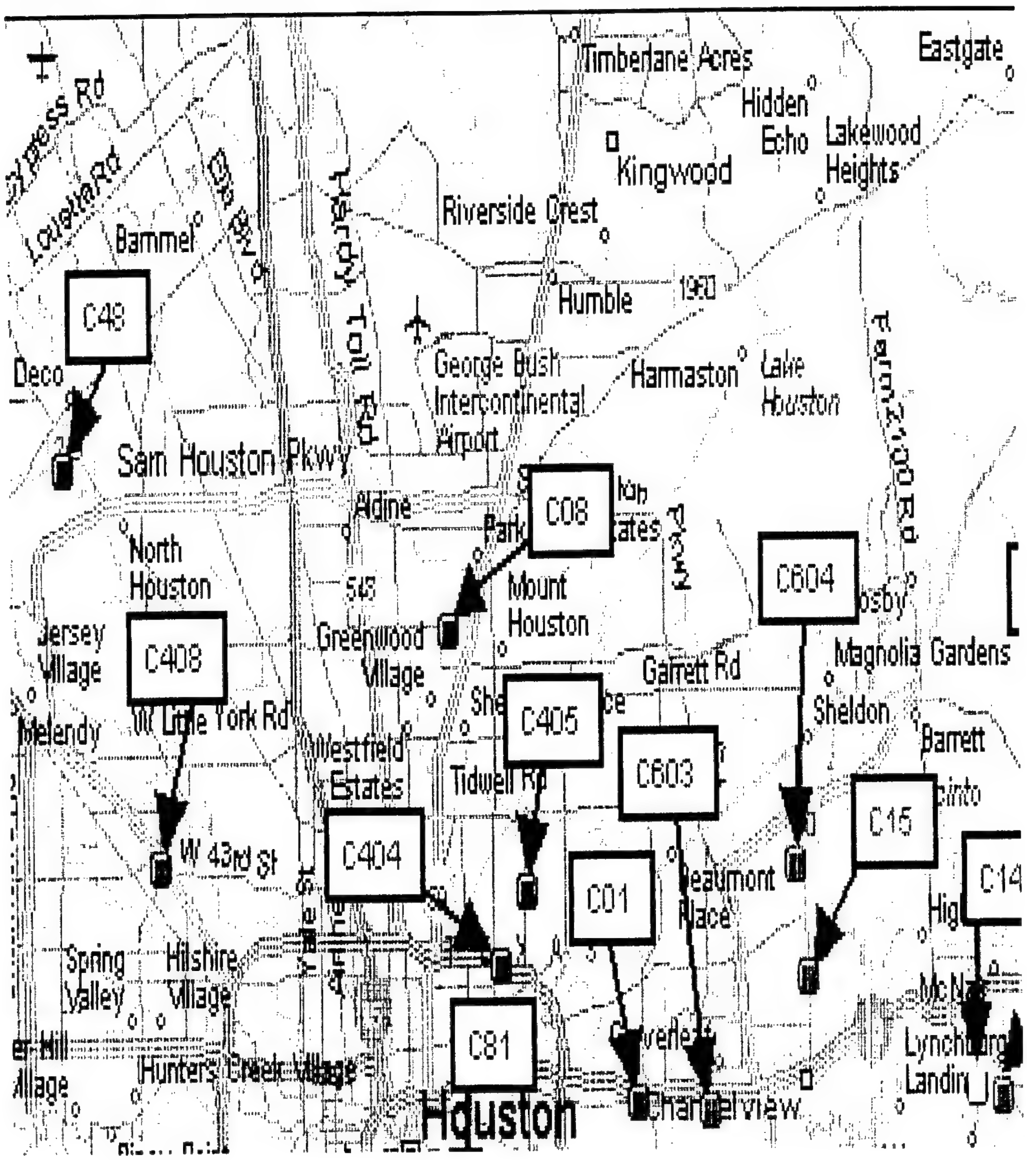


Illustration II-11 Aldine street map

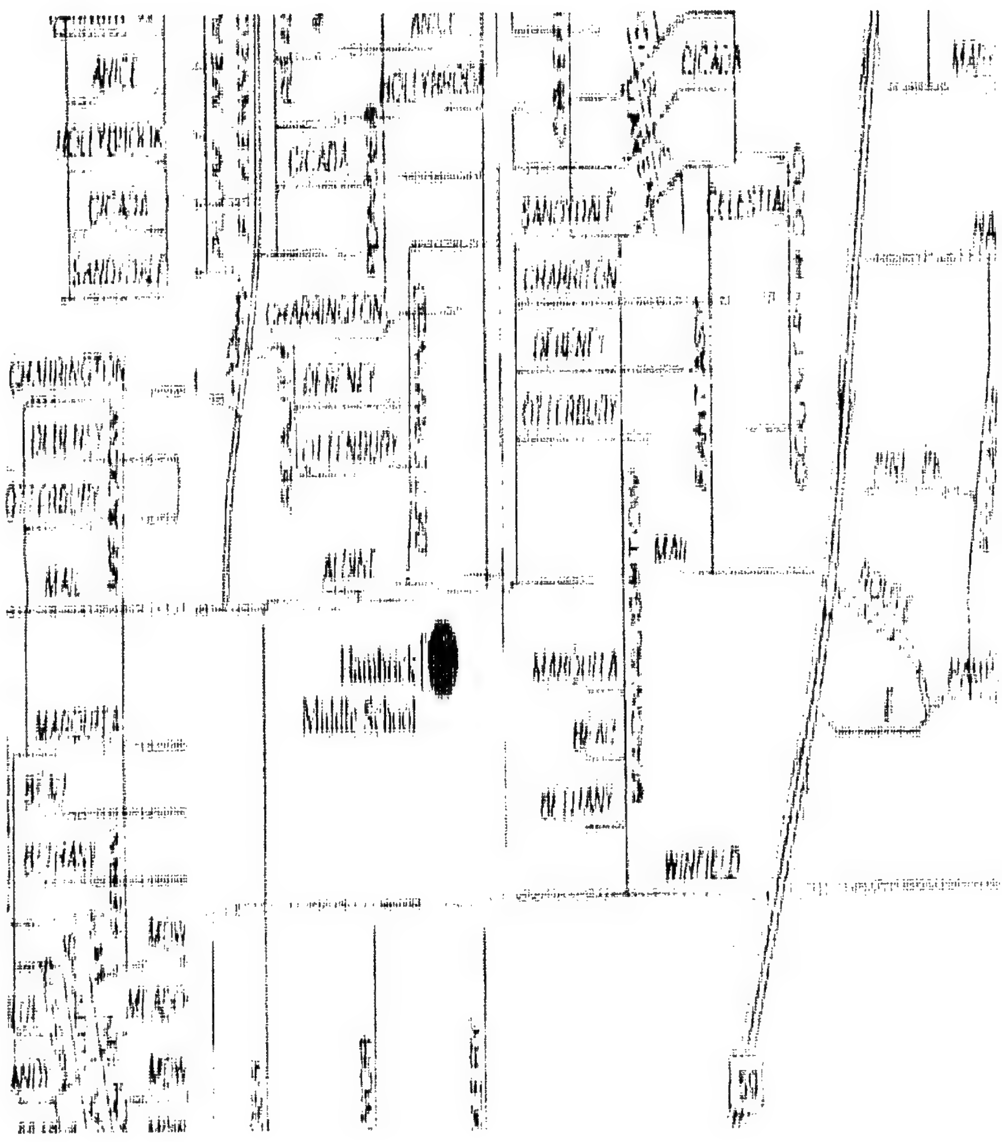
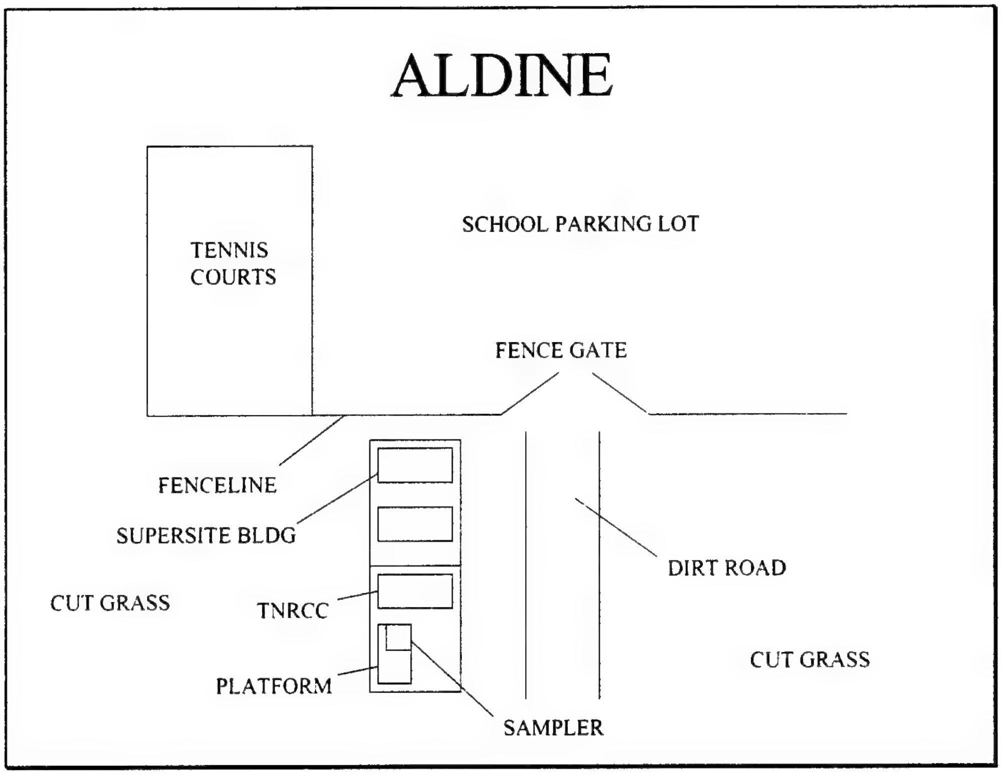


Illustration II-12 Aldine site map



The sampling strategy also included a downwind urban site at Aldine. When the wind is blowing inland off of the Gulf of Mexico, emissions from both the Ship Channel industrial sector and the downtown urban core will be aged, reacted, and transported to the northwest. Of course, on the other hand, there is also the possibility that relatively clean air will be sampled at a site like Aldine when the wind is blowing to the southeast and toward the city. With the exception of the cut grass of the surrounding athletic fields, there is very little tall vegetation within a significant distance. The small dirt road directly beside the sampling site was used fairly frequently at various times of the day. The sampler was located on a ten-foot platform.

II.2.6 Conroe (C65)

Illustration II-13 Conroe regional map

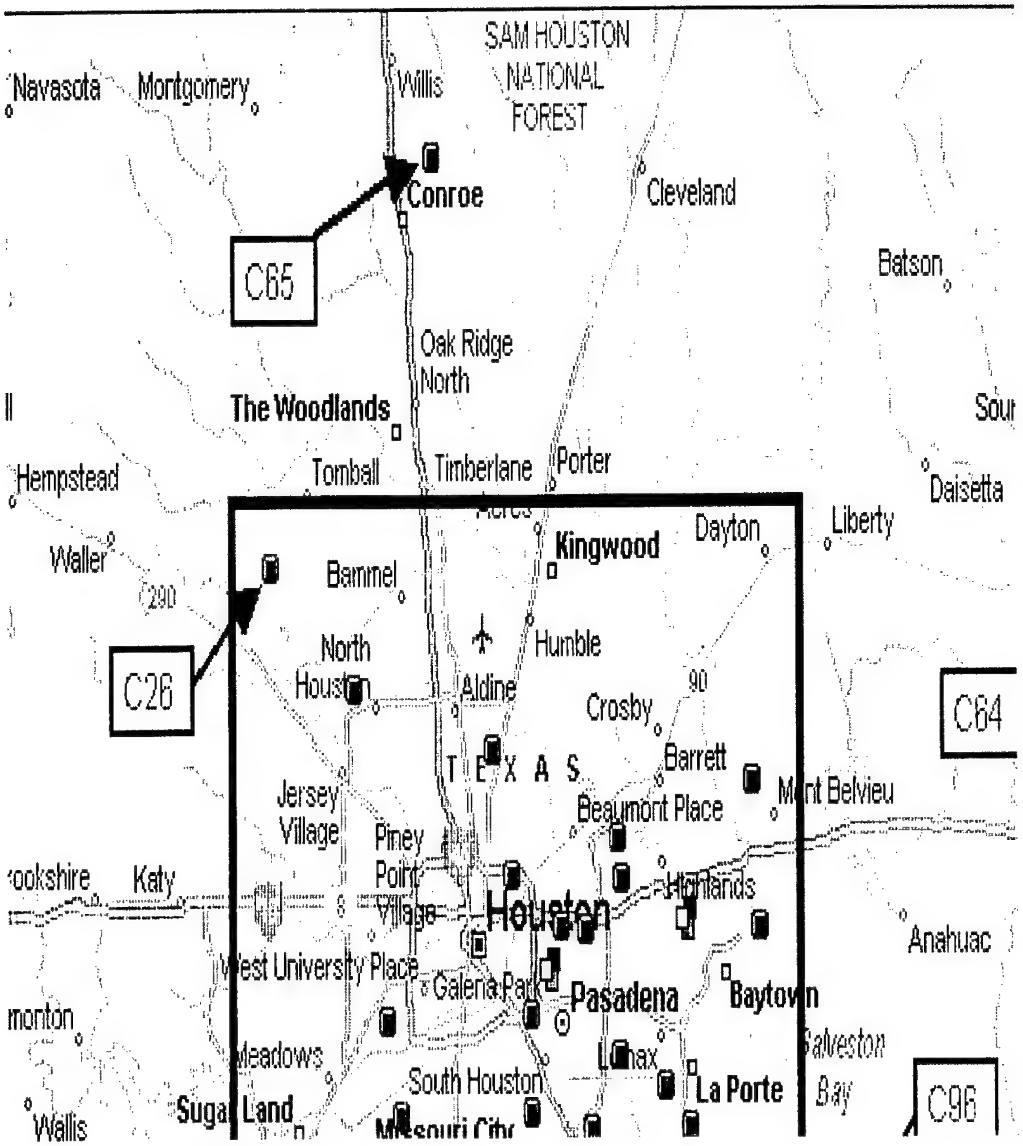


Illustration II-14 Conroe street map

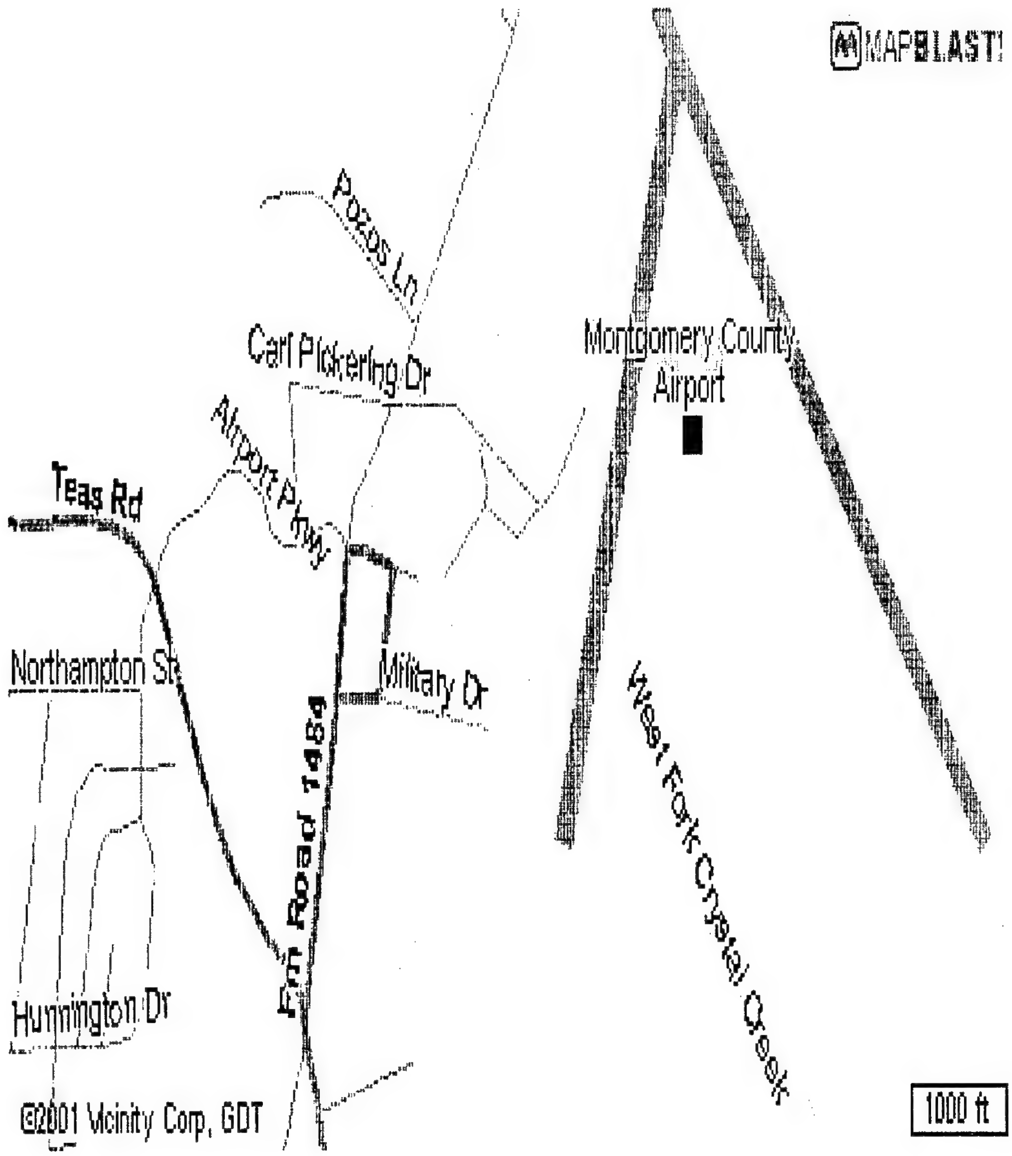
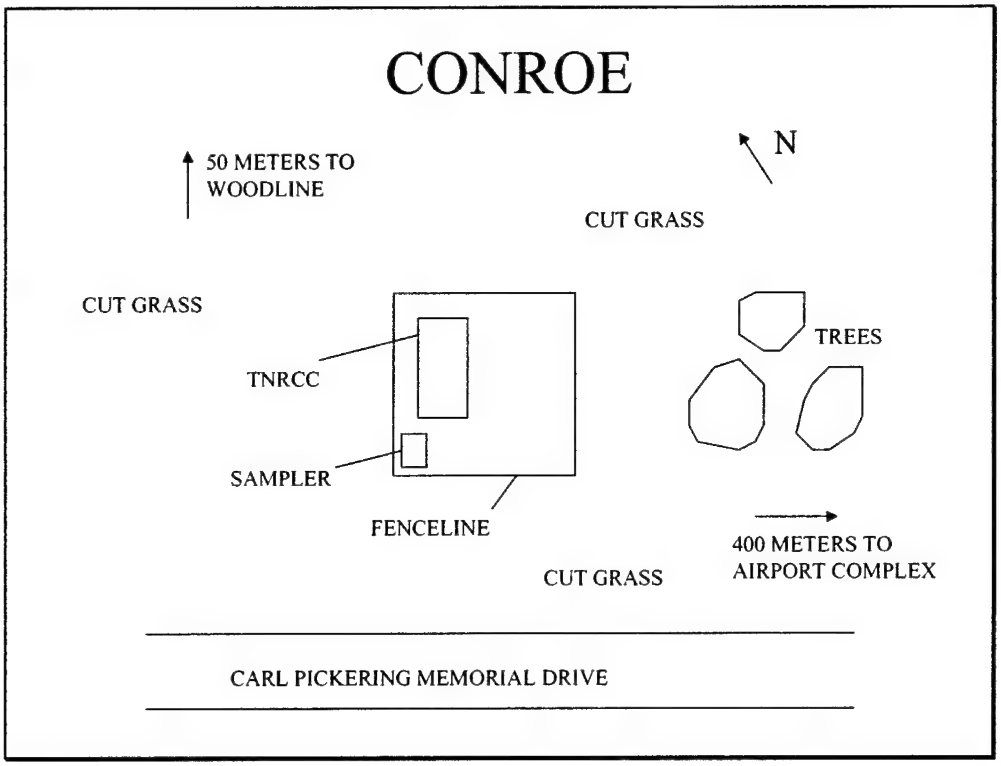


Illustration II-15 Conroe site map



With the overall intent of exploring the natural (vs. manmade) contribution to atmospheric chemistry in Southeast Texas, a sampling strategy has to include at least one site where a substantial amount of biogenic emissions is expected. The Conroe site, located beside the Montgomery County Airport, is in close proximity to the Sam Houston National Forest. The site is also located approximately forty to fifty miles from downtown Houston. Therefore, depending on the direction of the wind, an air sample collected from Conroe should not contain a significant amount of urban emissions. There is a substantial amount of tall trees immediately to the north-northeast of the site. The sampler was placed on the concrete pad.

II.3 SAMPLE COLLECTION

II.3.1 General

Both ambient air samples for VOC analysis and particulate matter samples were collected. The ambient air samples were collected into 32-liter stainless steel canisters for radiocarbon, or carbon-14, analysis of the nonmethane volatile organic carbon (NMOC) components in order to understand the distribution of the anthropogenic-biogenic sources of NMOCs. A major part of the strategy for collecting samples for radiocarbon analysis included reducing CO_2 levels as much as possible. Carbon dioxide is relatively abundant in the atmosphere (at levels of approximately 360 ppm), whereas total NMOC is about one thousand times smaller on a per carbon basis. ManTech personnel, who provided the training for field collection, provided equipment for a technique that they developed, which employs a lithium hydroxide (LiOH) scrubber to remove most of the CO_2 without unduly impacting the NMOC content. Particulate samples were collected with MSP® samplers in order to allow several subsequent analyses: organic carbon/elemental carbon (OC/EC) analysis, radiocarbon analysis of filter sections, and radiocarbon analysis of filter extracts. Gasoline and vegetation samples were also collected to allow better understanding of the VOC sources (Stiles, 2000).

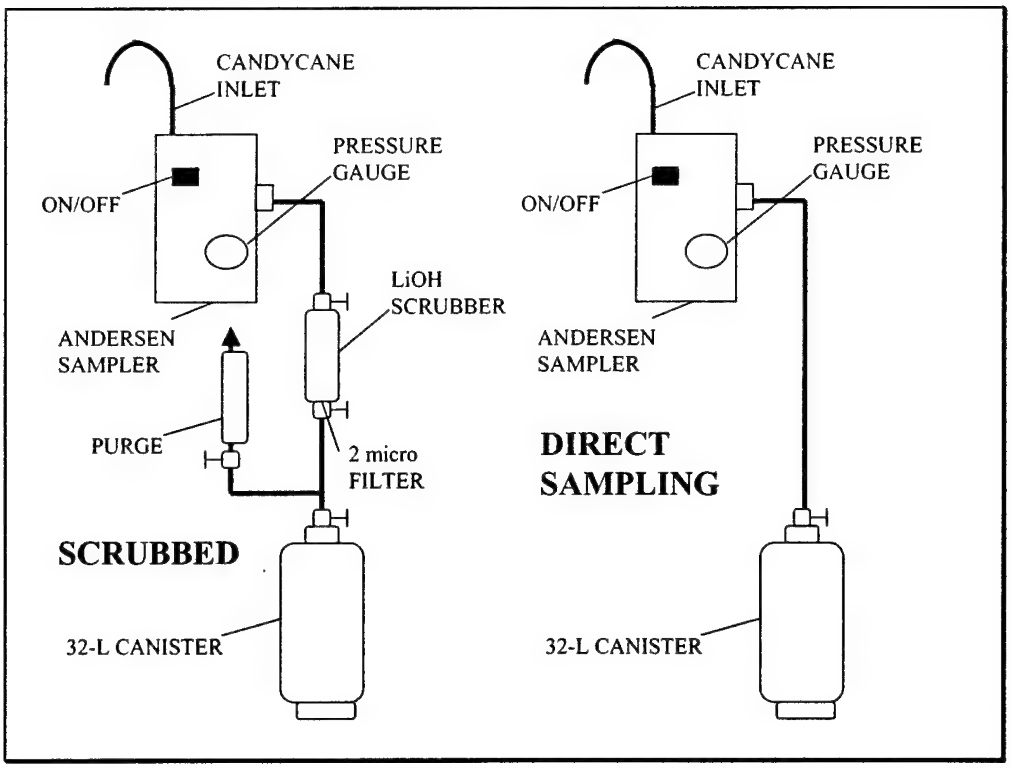
II.3.2 Volatile Organic Carbons

II.3.2.1 Sampler, Scrubber, and Canister Preparation

The configuration of the equipment used to collect CO_2-free and direct ambient air samples is shown in Figure II-1. The system uses two Andersen

VOC samplers to fill the 32-liter canisters. Andersen sampler #813024 was modified by adding a LiOH scrubber and two valves to the sample transfer line. Andersen sampler #813022 was used to fill a canister directly. The two samplers were cleaned before being sent to the field by washing the inlets, filters, and transfer lines in deionized water and drying them in an oven at 100 °C. The samplers were then reassembled and purged with humidified scientific-grade air (HSGA) overnight. A sample of HSGA was then pumped by each sampler into the sample inlet of a Shimadzu GC-FID system and analyzed for total NMOC to confirm that the sampler contributes less than twenty ppbC to the total NMOC.

Figure II-1 VOC sample collection setup



Four LiOH scrubbers were constructed from 150-cc Whitney stainless steel tubes. Each Whitney cylinder was washed in deionized water and dried in an oven at 110 °C. Each tube was then filled with LiOH sieved to a granule size of 1-2 mm in diameter. A fresh supply of the LiOH, purchased from Cypress Foote, was opened on 20 JUL 2000 to begin making these scrubbers. Approximately130 cc of LiOH was added to the cylinder and each end was packed with glass wool. Each scrubber was conditioned by passing humidified, low-CO_2, scientific-grade air through the scrubber for several hours while maintaining the scrubber temperature at approximately 105 °C. After conditioning, each scrubber was allowed to cool down and then capped until used (Stiles, 2000).

Prior to use in the fieldwork, all 32-liter canisters were cleaned and tested for blank NMOC levels and for vacuum integrity. The following is a summary of the cleaning, evacuation, and certification procedure:

1) Each can was first flushed of its original contents and partially refilled to approximately 0.5 atm with humidified scientific-grade air (HSGA) using a vacuum pump (Drytel Model 31).
2) Four canisters at a time were connected to a cleaning system manifold, placed in the oven, and allowed to hot soak at 150 °C for at least a couple of hours.
3) After hot soaking, the vacuum pump was turned on, and the four canisters were evacuated while being heated. The evacuation process continued overnight until the manifold pressure reading was less than 25 mT.

4) The four canisters were taken out of the oven and allowed to cool while the next four cans were connected to the oven manifold and processed using steps one through four.
5) After cooling, each canister was refilled to approximately 15 psig with HSGA. The blank levels of total NMOC for each canister were measured and compared to the blank total NMOC levels of the HGSA using a Shimadzu GC-FID system.
6) If a canister contributed more than 20 ppbC to the blank NMOC levels, then the canister was reevacuated, refilled with the HSGA, and retested.
7) If a canister continued to have high blank NMOC levels, the can was recleaned using steps one through five. (Note: None of the canisters used for this study had to be reheated to pass the test.)
8) After a canister was certified to contribute less than 20 ppbC to the blank NMOC levels, it was reevacuated (one at a time) using a Drytel Model 31 vacuum pump. The canister was heated during the final evacuation by using the following setup: each can was connected to the vacuum pump with the canister valve and two isolation valves initially closed and placed inside of an open-topped five gallon metal container while hot air from a heat gun was blown across the outside of the canister. This provided enough heat to raise the canister temperature to approximately 50 °C and helped to remove water vapor from the canister.

9) The isolation valves on the manifold were opened, and the manifold was evacuated and checked for leaks before the canister valve was opened. After the canister valve was opened, the canister continued to be evacuated while being heated to approximately 50 °C until the pressure equilibrated to less than 12 mT. (This step took several hours.)
10) The canister and pressure sensor were then isolated from the vacuum pump, and the pressure was observed for about one minute. The pressure normally equilibrated in less than one minute. This measured pressure was recorded.
11) If the measured pressure was less than 12 mT, the canister valve was closed, the two isolation valves were closed to prevent an influx of room air, and the canister was disconnected from the manifold. The procedure for this canister continued with step fourteen while the next canister was installed to begin the evacuation procedure using steps eight through ten.
12) If the measured pressure was greater than 12 mT, the heating and evacuation procedure was continued at step nine for a few more hours.
13) If the pressure did not equilibrate, but continued to increase noticeably, the can was tagged to be repaired and recleaned because of a potential leak.

14) Each canister was allowed to sit for at least one day and then reconnected to the vacuum manifold of the Drytel Model 31 pump. The vacuum manifold lines were evacuated until the pressure equilibrated to less than 10 mT and also less than the previously recorded pressure for this canister. The manifold and sensor were then isolated from the vacuum pump, and the manifold pressure was observed to make certain that the connections did not leak. If no leaks were observed, the valve on the canister was opened and the canister pressure was measured.
15) As soon as the pressure reading stabilized, the pressure was observed, and the canister valve was closed. The pressure that was measured after at least one day was compared to the pressure measured earlier.
16) If the latest measured pressure was less than one mT larger than the previous value, then the canister was marked as clean and "leak free." A label indicating the cleaning date, final pressure, and total NMOC blank level was made and attached to the canister.
17) If the latest measured pressure was measurably larger than the previous measurement, the can was tagged to be repaired and recleaned because of a potential leak (Stiles, 2000).

II.3.2.2 Field Setup and Sample Collection

The Anderson VOC samplers were transported to the field study site in an EPA GC/MS sampling and analysis trailer. Upon arrival in Houston, both VOC samplers were set up at the Aldine site on a ten-foot platform. Later in the study, the Anderson samplers were moved to the Washburn Tunnel, HRM-3,

and Conroe sites in and near Houston to collect samples at different sites. Appendix VI.1.1 lists the sampling times, locations, environmental conditions, and other useful parameters.

II.3.2.3 Sample Shipping and Storage

The 32-liter canisters were shipped back to Research Triangle Park, North Carolina, in custom boxes, three or four at a time via Federal Express. The CO_2 and TO-12 analysis (see Appendix VI.1.2) were performed as soon as possible, and feedback of the results was provided to the field personnel in Houston in order to ensure that acceptable levels of carbon dioxide were being removed by the LiOH scrubber. The canisters were eventually transferred for subsequent speciated nonmethane hydrocarbons using TO-14 techniques (see below).

II.3.2.4 Speciation

The Cryogen Gas Chromatographic-Flame Ionization Detection (Cryo GC-FID) System consists primarily of three components including the GC system, a preconcentration device, and a data integration system to determine VOC identification and concentration. Each component will now be described.

The gas chromatograph (GC) is a Hewlett-Packard Model 5890A Series II combined with flame ionization detection (FID). The GC column used in the system is a 0.32 millimeter inner diameter fused silica column containing a one micron DB-1 coating. In operation the column conditions consist of a -50°C initial temperature for two minutes followed by temperature programming to 200°C at a rate of 8°C per minute. After a 7.75 minute hold period, the column temperature is programmed to 225°C at a rate of 25°C per minute rate and held

at that temperature for eight minutes. These temperature conditions provide separation of the C_2-C_{12} hydrocarbons, a major portion of the gas phase VOCs. Liquid nitrogen is used as the cryogen to obtain the sub-ambient temperatures required within the programming sequence. An electronic pressure control (EPC) device is used to maintain column head pressure of the helium carrier gas at a constant value of 150 kPa throughout the analysis period. The 150 kPa pressure provides a column flowrate of 2.65 cubic centimeters per minute at 75°C.

The FID requires the use of hydrogen and air for operation. To maximize response, a nitrogen makeup gas is recommended. For FID operation the flowrates for hydrogen, air, and nitrogen are adjusted to and maintained at 48, 325, and 30 cubic centimeters per minute, respectively. The detector is heated to and maintained at 275°C (Lonneman, 2000).

The preconcentration system consists of a six-port gas sample valve configured to use a packed glass bead trap in place of a sample loop. The sample valve is a low/dead volume, diaphragm valve selected for low maintenance and reliable operation. The glass bead trap consists of a 25 centimeter by 3.2 millimeter stainless steel trap packed with sixty to eighty mesh untreated glass beads. Other components of the preconcentration system include a ballast tank (approximate 1.8 liter volume), a diaphragm pump, and a vacuum gauge.

The components were arranged to isolate the ballast tank from the sample valve, and to selectively flow sample air or helium through the glass bead trap. A helium flow of 70 cubic centimeters per minute is routed through the trap in a backflush mode, compared to that of air sample flow during time periods other than air sample trapping.

Preconcentration operation steps are performed in the following sequence:

1) The ballast tank is isolated from the sample valve and is evacuated to a pressure of 40 millimeters Hg.
2) At the same time, the trap is immersed with a dewar of liquid argon (-187°C).
3) When the trap reaches liquid argon temperature equilibrium, the sample valve is switched to its inject position, helium trap flow is stopped, and sample air is drawn into the trap by the vacuum differential in the ballast tank.
4) When the gauge pressure reaches 60 millimeters Hg, the sample valve is pneumatically switched to its fill position routing sample air through the glass bead trap. Sample air flow through the trap is maintained at about 120 cubic centimeters per minute.
5) When the gauge pressure reaches 180 millimeters Hg, air flow through the trap is stopped.
6) A series of operations are performed including switching the valve to its inject position, removing the dewar containing liquid argon, and replacing it with a dewar containing hot water (100°C), in that sequence.
7) The trapped VOCs are injected onto the GC column maintained at -50°C, and the temperature programming sequence is started.
8) After a 2.25 minute injection time, the valve is switched back to its fill position, and the trap is flushed with helium to prepare for the next preconcentration sequence. Trap temperature during the 2.25 minute injection period generally decreases from 99 to 92°C.

Tests with both ambient air samples and known standard mixtures have shown that the 2.25 minute trap injection period is at least 0.5 minutes longer than the required time to quantitatively inject the C_2-C_{12} hydrocarbons onto the GC column at the 99°C trap temperature (Lonneman, 2000).

Digital data provided by the Hewlett-Packard A/D board is accessed by the Chrom Perfect-5890 Direct chromatographic software program installed on the Hewlett-Packard Vectra Model 486/66XM IBM compatible computer. The chromatographic program acquires the time and voltage digital signal and electronically records the signal as RAW data files for later processing. The RAW data files are later accessed by chromatographic software and, using selectable threshold, peak width, and time event settings, GC peak areas are quantitatively integrated and stored along with retention times in AREA files. The AREA files are used by another software program, HCID, to name the GC peaks and convert peak areas to ppbC (Lonneman, 2000).

II.3.3 Particulate Matter

II.3.3.1 MSP Sampler Preparations

Two MSP Model 300 samplers were used in the field study. This model of MSP sampler operates nominally at 300 liters per minute and is configured to collect both a fine-fraction filter sample (particle aerodynamic diameters of 2.5 µm and below) and a coarse-fraction filter sample (particle aerodynamic diameters from 2.5 µm up to the upper cut point of the inlet). Each of the samplers was outfitted with a "rain hat" that is known to provide an upper cut point of approximately 10 µm (note that the exact value is not important for this study). The two samplers were marked with simple identifiers that allowed

their locations to be easily tracked through the field study. The first was labeled #1 and was identified with EPA property sticker 666781. The second was labeled #2, and it had EPA property identification 666783. These were the same samplers that had been used in a similar Nashville 1999 study (Stiles, 2000).

The two samplers were tested for proper mechanical operation at Research Triangle Park. For the Nashville study, only one of the two samplers had been modified to accept 90-mm-diameter filters for the collection of fine-fraction particulate matter. In preparation for the TEXAQS 2000 study, the second of the samplers was modified. Two 2.5-µm cut point impactor heads were used in the study; one was labeled with the manufacturer's serial number 027 and the second with 029. The first jet (where the pressure-drop sensing for flow control takes place) of head 029 was reepoxied to provide a more secure connection. All of the impactor jets for both heads were cleaned with Q-tips and solvent prior to the fieldwork (Stiles, 2000).

A supply of 90-mm prefired quartz filters for fine-fraction MSP sampling was heated to 500 °C and then placed in tight screw-top aluminum-foil-lined amber jars. Sections (2.5 by 6.5-inch) of quartz filter material for coarse-fraction sampling were cut from untreated 8 by 10 inch filters.

II.3.3.2 MSP Setup and Field Study Operations

The MSP samplers were transported to the field study site in the VOC GC/MS sampling and analysis trailer. Upon arrival in Houston, one MSP sampler was set up at the Aldine site on a ten-foot platform. Space in a nearby trailer was provided for loading and unloading filters and other preparations. The other MSP was set up initially at the Conroe site north of Houston. Later in

the study, the MSP samplers were moved to other sites. Appendix VI.2.1 lists the sampling times, locations, environmental conditions, and other useful parameters.

For a number of sampling episodes, the Omron timer hardware of the MSP sampler was used to start or finish runs automatically without the operator needing to be present. These runs are indicated by the word "Timer" in Appendix. Due to the use of this timer, many of the values for the "Initial" and "Final" magnehelix ratings that are reported represent the desired set points rather than the actual readings observed at the start/stop of a sampling period.

For the most part, the samplers operated satisfactorily. However, sampler #1, the "traveling" sampler that was relocated several times, exhibited many erratic readings of the major flow magnehelix. Almost continuously at times, the gauge would dip suddenly by about 10% and then return just as quickly to the set point. The changes seemed to occur faster than the blower could actually respond, so the impact on the total flow is unknown. Subsequent troubleshooting to date at Research Triangle Park has not identified the source of the problem or defined its impact, although it is still thought to be small (Stiles, 2000).

II.3.3.3 Sample Shipping and Storage

The 90-mm quartz filters were returned from the field via overnight Federal Express shipment, as two groups packed in a cooler filled with blue ice packs. Filters had been placed in individual petri dishes, each doubly wrapped with aluminum foil, labeled by date, time, and site, and placed as groups of approximately eight to ten in zip-lock freezer bags. The first return shipment showed that one of the blue ice packs had leaked. The outsides of the zip-lock

bags were wiped clean; the leakage did not appear to have an impact on the filter sample integrity. Coarse-fraction filter sections (2.5 by 6.5 inch) were retained by using the same storage techniques as the fine-fraction filters (Stiles, 2000).

II.3.3.4 C_eC_v (EC/OC) Analysis

A total of eighty-four samples were submitted to Sunset Laboratory for C_eC_v (EC/OC) analysis. They included seventy-three ambient field samples, two backup filter field samples, eight field blank samples, and a transportation blank. A group of four specified filters and six randomly selected filters were designated to have a duplicate analysis performed.

The terms "elemental carbon," "soot," "black carbon," and "light-absorbing carbon" in suspended particles are used loosely and often interchangeably by air quality, atmospheric, health, and industrial researchers. EC is not found in the atmosphere in its purest forms of diamond (four carbon bonds) or graphite (three carbon bonds). Atmospheric "elemental carbon" particles are commonly considered to be the product of incomplete combustion of carbon-containing fuels in an oxygen-starved environment. Organic carbon is considered nonabsorbing and more volatile than elemental carbon, although different researchers use different volatility cut-points for distinguishing between EC and OC. The sum of all components is total carbon (TC). Because definitive standards for OC and EC are lacking, these terms are defined by the method or protocol applied rather than as a fundamental quantity (Chow, 2001). Nevertheless, the EC/OC data provide some insight into whether or not primary combustion aerosol (soot) is significant.

The samples were delivered in an ice chest to Sunset for transfer to temporary storage in their cold freezer prior to analysis. Sunset was instructed to pick off any obvious debris from the filters, to select analysis sections (1 by 1.5 centimeters) from a noncentral area, and to apply NIOSH Method 5040. Analysis results were requested to be provided with no blank corrections being made (See Appendix VI.2.2). Sunset was instructed to return the remaining filter fractions to cold storage so that they could eventually be returned to the EPA for further disposition (Stiles, 2000).

II.3.3.5 Radiocarbon (^{14}C) Measurements

In the interest of obtaining results quickly, twenty three filters were selected by the University of Texas to be sent from the EPA to the National Institute of Standards and Technology (NIST) to begin the process for Radiocarbon (^{14}C) Measurements (all of the remaining filter samples will be analyzed at a later date). Four basic criteria were used to select the samples:

1) Varying Emission Signatures—anthropogenic industrial, anthropogenic mobile, biogenic, marine background, and fire events
2) Varying Sites—Aldine, Conroe, Galveston, and HRM-3
3) Varying Duration and Start Times—twenty-four hour sampling vs. six-hour sampling, and different start times of 0600, 1200, and 1800
4) Varying Elemental Carbon to Total Carbon Ratios—less than 0.1, 0.1 to 0.2, and greater than 0.2 (note that higher ratios were assumed to indicate a higher proportion of soot from fossil fuel combustion)

EC/TC ratios were especially critical for choosing those samples that will provide a variety of $^{14}C/^{12}C$ scenarios to examine. The twenty-three samples chosen from the four different sites are shown in Table II-1.

Table II-1 Samples selected for priority analysis

SITE	SAMPLE NUMBER	DATE SAMPLED	EC/TC RATIO
Aldine	2	09-Aug-00	0.25
Aldine	6	12-Aug-00	0.11
Aldine	8	13-Aug-00	0.06
Aldine	11	14-Aug-00	0.12
Aldine	12	15-Aug-00	0.28
Aldine	17	18-Aug-00	0.09
Aldine	18	19-Aug-00	0.08
Aldine	25	23-Aug-00	0.11
Aldine	28	25-Aug-00	0.17
Conroe	3	09-Aug-00	0.15
Conroe	6	13-Aug-00	0.04
Conroe	7	13-Aug-00	0.03
Conroe	11	30-Aug-00	0.08
Galveston	1	20-Aug-00	0.10
Galveston	4	22-Aug-00	0.09
Galveston	7	24-Aug-00	0.12
HRM-3	5	18-Aug-00	0.14
HRM-3	10	05-Sep-00	0.10
HRM-3	11	06-Sep-00	0.08
HRM-3	12	07-Sep-00	0.16
HRM-3	13	07-Sep-00	0.06
HRM-3	14	08-Sep-00	0.09
HRM-3	16	13-Sep-00	0.20

Preparing carbonaceous material deposited on quartz fiber filters for ^{14}C accelerator mass spectrometry (AMS) involves three separate steps: (1) the isolation of the carbon fraction of interest, (2) the combustion of sample carbon to CO_2, and (3) the subsequent reduction of the CO_2 to graphite, the form of carbon required for AMS analysis. Sample aliquots of sufficient area are taken from the ambient samples such that between 80 and 100 μg C may be

recoverable whenever possible. All samples are then treated to remove carbonate-bearing geological materials. Sample aliquots are subjected to hydrochloric acid fumes for six hours with subsequent neutralization using sodium hydroxide. The carbon remaining after this procedure is designated non-carbonate carbon. Aliquots are placed in precleaned quartz tubing, evacuated, and converted to CO_2 via combustion at 900°C using copper (II) oxide. The CO_2 is cryogenically distilled, quantified in a calibrated volume, and transferred to a quartz breakseal tube for storage prior to AMS target preparation.

Accelerator mass spectrometry measurements are performed using samples prepared as Fe-C bead targets instead of the normal pressed graphite powder. To minimize the target preparation blank, the Fe-C beads are produced using a closed system approach. The sample CO_2 is cryogenically transferred into a quartz reduction tube containing manganese (as the reducing agent) and iron wool catalyst, both of which were pretreated to minimize carbon artifacts. Batches of sample reduction tubes were placed into a furnace at 600°C for twenty-four to forty-eight hours where the CO_2 is reduced into graphitic carbon on the iron wool. The Fe wool-graphite matrix is magnetically separated from the manganese and sealed off under 10 kPa of ultrahigh purity helium. The fused target bead is then formed by melting the Fe wool-graphite in a resistive furnace at 1575°C for approximately one minute. Accelerator mass spectrometry measurements are then made at the University of Arizona-NSF AMS Facility (Klinedinst, 1999).

II.3.4 Gasoline Samples

II.3.4.1 Sample Collection

A set of fifteen gasoline samples was collected on 1 August and 2 August 2000. The samples represented low-octane, mid-octane, and premium grades for five of the major brands of gasoline sold in the Houston, Texas, area. For practical reasons, the selection of gasoline brands sampled was determined largely by their number of entries in the Yellow Pages of the Greater Houston phone book. The specific stations selected to represent each brand of gasoline were chosen on the basis of being in the approximate area of the Aldine sampling site. Approximately one gallon of fuel for each grade was pumped into the fuel tank of a rental vehicle before a one-pint sample was collected. Each sample was collected and stored in a tin-plated steel one-pint can with a screw cap.

II.3.4.2 Sample Shipping and Storage

For shipping, the cans were placed in a five-gallon plastic bucket with a tight-fitting cover. Sufficient vermiculite was added to each bucket to prevent movement of the cans during transport. Arrangements were made with Yellow Freight Systems for the shipping. Appropriate hazardous-shipping labels were attached to the buckets. Upon arrival at Research Triangle Park, the samples were stored in a flammables cabinet.

II.3.5 Vegetation Samples

Table II-2 lists the locations of tree leaf and other vegetation samples collected by George Klouda of NIST in August 2000. Samples were collected

in zip lock bags and taken to NIST for storage and analysis.

Table II-2 Vegetation sample details

Site	Where	Description
Aldine	From tree line across field southeast of samplers	Tree leaves
Conroe	From trees near site	Tree leaves
HRM-3	Bushes near rail tracks and sampler platform	Leaves
Laporte	Open field near site	Tall weeds

II.4 ADDITIONAL SOURCES OF DATA

II.4.1 General

There are three additional sources of data that will be repeatedly utilized within the results section. They are as follows: 1) TNRCC monitoring site data, 2) EPA SPECIATE source profiles, and 3) AIRS elemental composition data. All three sources will be described next in more detail.

II.4.2 TNRCC Monitoring Site Data

The Texas Natural Resource Conservation Commission maintains continuous measurements of many parameters, relevant to atmospheric science, at various monitoring stations throughout the state. This information is available at the TNRCC's website at www.tnrcc.state.tx.us. For this particular work, the meteorological data, as well as PM and ozone values, was extracted for all sampling sites, excluding the Washburn Tunnel, for the entire TEXAQS period of 7 August to 17 September 2000 (See Appendix VI.3 to VI.6).

II.4.3 EPA SPECIATE Source Profiles

The Environmental Protection Agency has made available through the website www.epa.gov/ttn/chief/software/speciate/index.html a software program entitled SPECIATE. This program contains 376 profiles of sources of particulate matter. A particular source profile can prove invaluable as a tool for making comparisons. For example, in order to assess whether or not a given filter sample contains traces of cigarette smoke, one can compare the elemental composition data of the sample with the standard elemental profile for cigarette smoke within SPECIATE to see how well the two sets of data match. The profiles of special interest in this case are those most closely associated with the production of young carbon (^{14}C) (See Appendix VI.7).

II.4.4 AIRS Elemental Composition Data

For a very limited number of days, the Aerometric Information Retrieval System contains elemental composition data for particulate matter sampled during the TEXAQS period at the various monitoring sites. Following EPA protocol, these values are FRM measurements from filters with a 2.5-micron cut point. X-ray fluorescence was used for quantifying trace elements. Ion chromatography was utilized for identifying nitrates, sulfates, and ammonium. Finally, OC and EC measurements were made with the same NIOSH Method 5040 mentioned in section II.3.3.4. All of the PM samplers that the TNRCC used to collect this information were co-located with the MSP samplers discussed within this work. Therefore, with a fairly high degree of certainty, it is reasonable to assume that elemental composition data from both sources would be virtually the same (See Appendix VI.8)

III RESULTS

III.1 SCOPE

The focus of this thesis is measuring the $^{14}C/^{12}C$ ratios in ambient atmospheric hydrocarbons and the use of these ratios in characterizing hydrocarbon sources. The information regarding hydrocarbon sources deduced from the $^{14}C/^{12}C$ ratios can be compared to information deduced from other atmospheric measurements that were described extensively in the methodology section.

This section describing the results will be structured in the following way. For a select group of sampling periods when extensive air quality measurements were made, $^{14}C/^{12}C$ ratios will be semi-quantitatively predicted. These predicted ratios will then be compared to the observed $^{14}C/^{12}C$ ratios.

III.2 PREDICTIONS

III.2.1 General

Out of the twenty-three filter samples initially prioritized for radiocarbon (^{14}C) measurements, only eleven samples have sufficient ancillary data that allows for predictions of the $^{14}C/^{12}C$ ratios. Therefore, only these eleven samples will be discussed in this part of the results section: 18, 19, and 25 August for Aldine; 20 and 22 August for Galveston; 30 August for Conroe; and 5, 6, 7, 8, and 13 September for HRM-3. All of the remaining twelve samples lacked the necessary supporting data, at this time, required for making an estimate of biogenic fraction. However, the results generated by NIST for all twenty-three filter samples and two blanks, if available, will be presented.

III.2.2 Format

Each of the eleven samples discussed in detail will be analyzed on a case by case basis and shown separately. Initially, miscellaneous data such as sample time duration and day of the week will be mentioned. Appropriate meteorological data such as average temperature, average wind speed, and wind direction will follow. Elemental carbon/total carbon (EC/TC) and organic carbon/elemental carbon (OC/EC) ratios will be shown. Then, various sources of organic carbon will be examined, and a possible value for OC attributable to secondary organic aerosol (SOA) will be presented. Finally, a rough estimate or prediction will be made of the fraction of ^{14}C or young carbon present. This process is intended to be qualitative in nature rather than quantitative.

III.2.3 Sources of ^{14}C

III.2.3.1 General

When discussing sources of particulate matter containing young carbon (^{14}C), there are both primary and secondary sources to consider. The main primary sources that are of concern for the purposes of this thesis are 1) forest fire activity, 2) cooking, and 3) vegetative detritus. Secondary sources require an estimate of secondary organic aerosol (SOA), and more specifically in this work, the fraction of the SOA that is due to biogenic emissions.

III.2.3.2 Organic Carbon Associated with Forest Fire Activity

Approximately half-way through the TEXAQS period (around 28 August to 5 September), there was substantial forest fire activity reported to the north/northeast of Houston. Depending on which way the wind was blowing for

any given day, these fires could have generated particulate matter collected in the samples. The Conroe site, located north of Houston, was particularly susceptible. To assess the contribution of the forest fire activity to the particulate matter collected, a standard profile of the elemental composition for "Forest Prescribed Burning-Broadcast Conifer" can be compared to elemental profiles for the collected samples (refer to Appendix VI.7.1 for SPECIATE data). The data in the appendix indicates that aside from a fairly large OC/EC ratio of approximately 9.343, there should be significant amounts of potassium, nitrates, and chlorine, with trace levels of sulfur, calcium, aluminum, and zinc.

III.2.3.3 Organic Carbon Associated with Cooking

An additional source of ^{14}C is the anthropogenic activity of cooking. Especially in an urban environment with a large population and a considerable number of restaurants, the organic carbon produced from cooking cannot be dismissed as trivial. A standard profile of the elemental composition for "Meat Cooking-Charbroiling" contains no elemental carbon and significant amounts of magnesium, chlorine, copper, and sodium (refer to Appendix VI.7.2 for SPECIATE data). A profile for "Meat Cooking-Frying" also contains no elemental carbon and significant amounts of chlorine, nitrates, sulfates, and barium (refer to Appendix VI.7.3 for SPECIATE data).

III.2.3.4 Organic Carbon Associated with Vegetative Detritus

Perhaps slightly less crucial than the impact of forest fire and cooking activity is the possibility of vegetative detritus. This process can be defined many different ways from the impact of strong winds breaking apart loose vegetation to the particulate matter created when mowing a lawn. Particles

from this source are expected to be large, typically greater than 2.5 μm. Regardless, a speciated filter sample should be checked for signs of this activity. A standard profile of the elemental composition for "Vegetative Detritus" shows a very large OC/EC ratio of 34.468 and contains significant amounts of silicon, iron, aluminum, calcium, copper, potassium, and zinc (refer to Appendix VI.7.4 for SPECIATE data).

III.2.3.5 Organic Carbon Associated with Elemental Carbon

For almost every process that produces elemental carbon, man-made or otherwise, there is typically a certain amount of organic carbon that is also present. In this work, all EC is assumed to be fossil carbon, and a characteristic OC/EC ratio for primary fossil carbon sources is assumed. Based on data collected and assembled by the EPA on particulate matter source profiles (SPECIATE), the ratio of organic carbon to elemental carbon can vary extensively from 2.53 for tire wear to 0.369 for jet aircraft, and everything in between. A fairly conservative average that includes many of the processes associated with an urban environment and its surroundings is 1.2. This value will be used in this work to create an upper bound to the possible biogenic fraction eventually estimated.

III.2.3.6 Biogenic Fraction of Secondary Organic Aerosol

Reiterating the fact that this portion of the analysis will be very qualitative in nature, the two main pieces of corroborating evidence for assessing a biogenic fraction of the SOA will include VOC data, when available and applicable and ozone data. To estimate the fraction of the SOA that might be due to biogenic emissions, all potential biogenic precursors of SOA should

be analyzed. These include isoprene from deciduous, or broadleaf, trees, as well as, α-pinene, β-pinene, and sesquiterpenes from conifers. Unfortunately, only measurements of isoprene are available.

At the Aldine site isoprene concentrations were near zero in the VOC samples analyzed by the TNRCC. At the Clinton site, a site not utilized for this thesis but located very near HRM-3, there were some substantial levels of isoprene reported. However, the peak concentrations seemed to occur primarily in the morning hours, and the day-to-day values were extremely inconsistent. For example, on 5 September 2000 the concentration at 1400 was 8.6 ppbC, but the following day, the concentration at 1400 was 0.13 ppbC. This type of pattern suggests that there may be an anthropogenic source of isoprene within the vicinity of the Clinton, and therefore HRM-3, site. From this, an assumption is made that SOA from the emissions of broadleaf trees is near zero, for the Aldine and HRM-3 sites, but the contributions from pines are unknown.

III.2.4 Aldine

III.2.4.1 *18 August 2000*

III.2.4.1.1 General

This sample was a six-hour sample taken from 1200-1800 on a Friday. The average temperature was 94.850 °F with a high of 96.7 °F at 1500. The average wind speed was 6.133 mph with a high of 9.1mph at 1700. For most of the sampling period the wind was blowing from the south/southeast, from the general direction of the ship channel and the urban core. The EC/TC ratio was 0.106 and the OC/EC ratio was 8.471. Both of these values seem reasonable on the surface. On one hand, the OC/EC ratio seems a little high given that for almost all of the sampling period the wind is carrying primary industrial and anthropogenic emissions from the southeast. However, taking into account that the average temperature was very high and the sample is primarily an afternoon sample when biogenic emissions are most significant, it is reasonable to expect significant secondary aerosol production.

III.2.4.1.2 Sources of Organic Carbon

For this particular filter sample, forest fire activity, cooking, and vegetative detritus do not appear to be much of a factor. The sampling occurred before the forest fire activity that occurred later on in the month. The elemental composition data does not match very well with the standard profiles for cooking. It lacks the magnesium and sodium normally associated with charbroiling. Frying also requires traces of sodium, and the barium level (0.151%) was too low to match its significance within the SPECIATE profile.

Considerable amounts of silicon, aluminum, and iron suggest the possibility of vegetative detritus. However, the lack of similar levels of copper, calcium, and zinc suggests otherwise.

III.2.4.1.3 Biogenic Fraction of Secondary Organic Aerosol

The sample contained 4.6 $\mu g/m^3$ organic carbon. Assuming that fossil organic carbon is associated with the fossil elemental carbon (0.543 $\mu g/m^3$ multiplied by 1.2), the OC from SOA is estimated to be: $4.6 - (0.543)(1.2) =$ **3.948 $\mu g/m^3$**. Given that the average ozone value for the sampling period was 90.8 ppb with a high of 111 ppb at 1500 when the temperature high also occurred, a substantial amount of secondary aerosol formation is plausible.

III.2.4.2 ***19 August 2000***

III.2.4.2.1 General

This sample was a 24-hour sample taken from 2400-2400 on a Saturday. The average temperature was 84.163 °F with a high of 96.3 °F at 1500. The average wind speed was 3.650 mph with a high of 8.8 mph at 1700. For the early morning hours to mid-afternoon (1500), the wind was blowing from the southwest. For the remainder of the day, the wind came from the southeast initially and gradually shifted from the south. These wind patterns do not exactly match the normal land-sea breeze shift observed in this area. The EC/TC ratio was 0.067 and the OC/EC ratio was 13.835. Both of these values seem reasonable. Since the sample occurred on a Saturday, there is a strong possibility that industrial and anthropogenic sources were not as prevalent as they might be on a weekday. With biogenic emissions remaining the same

regardless of what day of the week it is, an increase in the OC/EC ratio should be expected.

III.2.4.2.2 Sources of Organic Carbon

Similar to the 18 August sample, previously mentioned sources of organic carbon do not appear to be much of a factor. The sampling occurred before the forest fire activity that occurred later on in the month. As with 18 August, the elemental composition data does not match very well with the standard profiles for cooking. It too lacks the magnesium and sodium normally associated with charbroiling. Frying also requires traces of sodium, and the barium level (0.103%) was even lower than the 18 August sample. Considerable amounts of silicon, aluminum, and iron suggest the possibility of vegetative detritus. However, the lack of similar levels of copper, calcium, and zinc suggests otherwise.

III.2.4.2.3 Biogenic Fraction of Secondary Organic Aerosol

The sample contained 4.69 $\mu g/m^3$ organic carbon. Assuming that fossil organic carbon is associated with the fossil elemental carbon (0.339 $\mu g/m^3$ multiplied by 1.2), the OC from SOA is estimated to be: $4.69 - (0.339)(1.2) =$ **$4.283\ \mu g/m^3$**. Given that the average ozone value for the sampling period was 51.3 ppb (compared to a 24-hour average of 38.3 ppb for 18 August) with a high of 122 ppb at 1600, a substantial amount of aerosol formation is plausible. At the very least, the fraction of SOA in this sample should be more than the 18 August sample due to a much larger 24-hour ozone average.

III.2.4.3 *25 August 2000*

III.2.4.3.1 General

This sample was a 24-hour sample taken from 2400-2400 on a Friday. The average temperature was 82.717 °F with a high of 92.8 °F at 1500. The average wind speed was 3.383 mph with a high of 9.4 mph at 1600. For the early morning hours to early afternoon (1300), the wind was blowing from the northeast/east, and throughout the remainder of the day, it gradually shifted to originating from the southeast/south. These wind patterns were a little closer to the normal land-sea breeze oscillation observed in this area. The EC/TC ratio was 0.160 and the OC/EC ratio was 5.236. Again, both of these values seem reasonable. The presence of higher levels of elemental carbon, compared to 18 and 19 August, is consistent with a full 24-hour dose of weekday industrial and anthropogenic emissions. Also, out of the three Aldine samples, the average temperature is lowest for this sample (by almost 2 °F). This difference could reduce the amount of biogenic emissions.

III.2.4.3.2 Sources of Organic Carbon

The date of this sample is approaching the point when forest fire activity is conceivable. However, a lack of the potassium coupled with a very low OC/EC ratio makes the fire scenario unlikely. Signs of cooking activity seem to appear here. Trace levels of magnesium and levels of 0.111% copper and 0.448% sodium might indicate charbroiling. Frying is even more plausible given levels of 0.225%, 0.448%, and 0.221% of barium, sodium, and potassium, respectively. A complete lack of aluminum discredits the option of including vegetative detritus.

III.2.4.3.3 Biogenic Fraction of Secondary Organic Aerosol

The sample contained 3.77 $\mu g/m^3$ organic carbon. Accounting for other sources of OC, such as cooking (OC/barium ratio of 124.783), and assuming that fossil organic carbon is associated with the fossil elemental carbon (0.72 $\mu g/m^3$ multiplied by 1.2), the OC from SOA is estimated to be: 4.69 – (0.339)(1.2) – (0.0226)(124.783) = **0.086 $\mu g/m^3$**. Initially, despite the condition that the 24-hour ozone average (38.042 ppb) is the lowest of the three Aldine sampling events mentioned, this value seems a little low. The factor of 124.783 taken from the standard frying profile is probably too large. However, it is not unreasonable to estimate that this sample will, in fact, have the lowest amount of OC associated with SOA for the three Aldine samples.

III.2.4.4 Aldine Summary

Table III-1 displays some of the data for all three sampling periods discussed in this section.

Table III-1 Aldine summary

DATE	DAY	TYPE	TEMP Avg (°F)	WIND Avg (mph)	OC/EC	SOA ($\mu g/m^3$)
18 Aug	Fri	6-HR	94.850	6.133	8.471	3.948
19 Aug	Sat	24-HR	84.163	3.650	13.835	4.283
25 Aug	Fri	24-HR	82.717	3.383	5.236	0.086

Based on the information presented within this section, the sample taken on 19 August most likely had the highest biogenic fraction, and the sample collected on 25 August probably had the lowest (although, the strong evidence of a cooking profile may lead to a significant ^{14}C level in this sample). The OC/EC ratios alone seem to suggest the same predictions. As mentioned previously, VOC data for the Aldine site suggests that isoprene levels are close to zero on any given day. Therefore, in the absence of forest fire activity, significant cooking related particulate matter, and vegetative detritus, almost all of the young carbon measured on the filters will have to be attributed to biogenic emissions from sources such as conifer trees.

III.2.5 Galveston

III.2.5.1 *20 August 2000*

III.2.5.1.1 General

This sample was a 24-hour sample taken from 2400-2400 on a Sunday. The average temperature was 84.758 °F with a high of 87.2 °F at 1400. The average wind speed was 10.963 mph with a high of 13.7 mph at 0300. For the early morning hours to late morning (1100), the wind was blowing from the southwest. For the remainder of the day, the wind came from the south. These wind patterns do not exactly match the normal land-sea breeze shift observed in this area. The EC/TC ratio was 0.102 and the OC/EC ratio was 8.789. Both of these values might be explainable. Given that the sampling day is a Sunday and that the wind seems to be originating primarily from Galveston Bay, the expectation is that elemental carbon levels would be lower than shown here.

However, there is a substantial portion of the day from around 0600 to 0900 when the wind does shift briefly all the way to the northwest where anthropogenic emission sources are present.

III.2.5.1.2 Sources of Organic Carbon

In the absence of significant wind from inland, an assumption can be made that none of the sources of organic carbon mentioned previously, to include forest fires, cooking, and vegetative detritus, will be necessary for consideration with this sample. This statement does not imply the complete lack of these emission sources, it merely suggests that they will most likely not be present at significant levels.

III.2.5.1.3 Biogenic Fraction of Secondary Organic Aerosol

The sample contained 1.67 $\mu g/m^3$ organic carbon. Assuming that fossil organic carbon is associated with the fossil elemental carbon (0.19 $\mu g/m^3$ multiplied by 1.2), the OC from SOA is estimated to be: $1.67 - (0.19)(1.2) =$ **1.442 $\mu g/m^3$**. The average ozone value for the sampling period was 30.1 ppb (not that much lower than the 24-hour averages for Aldine), but the high was only 42 ppb at 1000. The fraction of the aerosol that is biogenic in origin will almost completely depend on what the wind is passing over from Galveston Bay. An anthropogenic source such as ship traffic might be conceivable.

III.2.5.2 *22 August 2000*

III.2.5.2.1 General

This sample was a 24-hour sample taken from 2400-2400 on a Tuesday. The average temperature was 84.942 °F with a high of 86.6 °F at 1400. The average wind speed was 7.942 mph with a high of 10.5 mph at 1600. For the early morning hours to 0500, the wind was blowing from the southeast. For the remainder of the day, the wind came from the east. These wind patterns do not exactly match the normal land-sea breeze shift observed in this area. The EC/TC ratio was 0.074 and the OC/EC ratio was 12.574. Both of these values seem reasonable. For a majority of the day the wind is blowing from the east, directly from Galveston Bay, where the possibility of elemental carbon from anthropogenic sources is very slim

III.2.5.2.2 Sources of Organic Carbon

In the absence of significant wind from inland, an assumption can be made that none of the sources of organic carbon mentioned previously, to include forest fires, cooking, and vegetative detritus, will be necessary for consideration with this sample. This statement does not imply the complete lack of these emission sources, it merely suggests that they will most likely not be present at significant levels.

III.2.5.2.3 Biogenic Fraction of Secondary Organic Aerosol

The sample contained 2.54 $\mu g/m^3$ organic carbon. Assuming that fossil organic carbon is associated with the fossil elemental carbon (0.202 $\mu g/m^3$

multiplied by 1.2), the OC from SOA is estimated to be: 2.54 – (0.202)(1.2) = **2.298 μg/m³**. Given that the average ozone value for the sampling period was 59.542 ppb (much higher than the 20 August Galveston sample) with a high of 72 ppb at 1000, a reasonable amount of aerosol formation is plausible. The fraction of the aerosol that is biogenic in origin will almost completely depend on what the wind is passing over from Galveston Bay. An anthropogenic source such as ship traffic might be conceivable.

III.2.5.3 Galveston Summary

Table III-2 displays some of the data for both sampling periods discussed in this section.

Table III-2 Galveston summary

DATE	DAY	TYPE	TEMP Avg (°F)	WIND Avg (mph)	OC/EC	SOA ($\mu g/m^3$)
20 Aug	Sun	24-HR	84.758	10.963	8.789	1.442
22 Aug	Tue	24-HR	84.942	7.942	12.574	2.298

Based on the information presented within this section, the sample taken on 22 August probably had a higher biogenic fraction then the 20 August sample. The OC/EC ratios alone seem to suggest the same prediction. Even with the total absence of VOC data, the possibility of a significant biogenic fraction is conceivable. Particularly the 22 August sample, where the wind passes over land very little enroute to the sampler, might show a substantial

marine biogenic contribution. Particulate matter attributable to forest fire activity, cooking, or vegetative detritus is unlikely. Even traces of isoprene, α-pinene, β-pinene, and sesquiterpenes seem doubtful.

III.2.6 Conroe—*30 August 2000*

III.2.6.1 General

This sample was a 24-hour sample taken from 2400-2400 on a Wednesday. The average temperature was 88.558 °F with a high of 103 °F at 1600. The average wind speed was 4.004 mph with a high of 7 mph at 1000. The wind was blowing from the southwest almost the entire day. The EC/TC ratio was 0.059 and the OC/EC ratio was 15.824. These two values seem a little more extreme than some of the numbers reported for the other sites. However, the wind does not really originate from Houston where most of the anthropogenic contributions of elemental carbon might be expected. This date was also a very hot day, and the site was in the vicinity of forestry capable of significant biogenic emissions.

III.2.6.2 Sources of Organic Carbon

The possibility of the sample containing particulate matter generated by forest fire activity in the near vicinity is likely. The elemental composition (particularly potassium—0.588%) for the sample matches well with the standard SPECIATE profile, but even more convincing is the particulate matter evidence. Briefly from 1800-2000, the wind shifts drastically to blowing from the east/northeast where much of the fire incidents were occurring. The PM levels, which had been very low all day, suddenly jump from 4.67 $\mu g/m^3$ at

1800 all the way to a high of 26.92 $\mu g/m^3$ by 2100.

Signs of cooking activity seem to appear here, as well. The absence of magnesium and slight trace amounts of copper (0.005%) seem to make charbroiling improbable. However, with the necessary level of barium (0.321%), compared to the standard SPECIATE profile, and a lot of sodium (1.199%), frying should probably be considered. Low levels of aluminum, copper, and zinc do not suggest that vegetative detritus is significant for this sample.

III.2.6.3 Biogenic Fraction of Secondary Organic Aerosol

The sample contained 2.88 $\mu g/m^3$ organic carbon. Accounting for other sources of OC, such as fire activity (OC/potassium ratio of 82.939) and cooking (OC/barium ratio of 124.783), and assuming that fossil organic carbon is associated with the fossil elemental carbon (0..182 $\mu g/m^3$ multiplied by 1.2), the OC from SOA is estimated to be: 2.88 – (0.182)(1.2) – (0.049)(82.939) - (0.0268)(124.783) = **0 $\mu g/m^3$**. Even disregarding the possibility of cooking and reducing the factor used to include fire activity down to 54.318, the OC from SOA would still be zero. The high for ozone at this site was only 75 ppb.

III.2.6.4 Conroe Summary

Given the very large OC/EC ratio and the close proximity of biogenic emitting sources, the assumption that the biogenic fraction of this filter sample is high seems completely justifiable. However, in the absence of supporting VOC data for this site, the evidence is substantial that a majority of the particulate matter collected on this sample can be attributed to forest fire activity within the area.

III.2.7 HRM-3

III.2.7.1 *5 September 2000*

III.2.7.1.1 General

This sample was a six-hour sample taken from 1200-1800 on a Tuesday. The average temperature was 99.467 °F with a high of 106.7 °F at 1300. The average wind speed was 4.467 mph with a high of 6.3 mph at 1300. The wind was blowing from the northeast initially until around 1600 when it shifted slightly to blowing from the east. The EC/TC ratio was 0.116 and the OC/EC ratio was 7.590. These values are justifiable in that higher levels of elemental carbon are expected in this highly industrial area. However, the OC/EC ratio is higher than that of the 25 August sample taken at Aldine (a suburban location), suggesting perhaps an unexpected source of organic carbon.

III.2.7.1.2 Sources of Organic Carbon

Despite this sampling site's fairly distant location south of where most of the forest fire activity was reported, the possibility of particulate matter collected at HRM-3 containing young carbon originating from this source cannot be ignored. Prior to this sampling period, the wind blew from the north all morning, and PM from the fires was in the region. The potassium level (0.653) is high enough to suggest agreement with the standard SPECIATE profile.

The evidence for cooking activity is present. Trace levels of magnesium (0.093%) and copper (0.008%) do not really suggest charbroiling as significant, but amounts of barium (0.217%) and sodium (0.825%) matched against the

standard SPECIATE profile will support the assumption of frying. The low levels of aluminum and zinc, and the near absence of copper does not make vegetative detritus likely.

III.2.7.1.3 Biogenic Fraction of Secondary Organic Aerosol

The sample contained 9.26 $\mu g/m^3$ organic carbon. Accounting for other sources of OC, such as fire activity (OC/potassium ratio of 82.939) and cooking (OC/barium ratio of 124.783), and assuming that fossil organic carbon is associated with the fossil elemental carbon (1.22 $\mu g/m^3$ multiplied by 1.2), the OC from SOA is estimated to be: 9.26 – (1.22)(1.2) – (0.163)(82.939) - (0.0543)(124.783) = **0 $\mu g/m^3$**. If the assumption of forest fire activity impacting this sample is incorrect, the SOA may be as high as 1.02 $\mu g/m^3$, still not a large value. Reducing the factor (82.939) used to include fire activity may increase its plausibility. Given that the average ozone value for the sampling period was 101.5 ppb with a high of 130 ppb at 1400, a reasonable amount of SOA would probably be anticipated.

III.2.7.2 *6 September 2000*

III.2.7.2.1 General

This sample was a 24-hour sample taken from 2400-2400 on a Wednesday. The average temperature was 88.65 °F with a high of 94 °F at 1500. The average wind speed was 3.967 mph with a high of 6.1 mph at 1900. The wind was blowing from the northeast, shifting to originating from the east, until around 1600, when it changed to blowing slightly from the southeast for about six hours before returning to coming from the northeast again. The

EC/TC ratio was 0.065 and the OC/EC ratio was 14.423. These values seem extreme and begin to rival the rural numbers seen at the Conroe site. However, substantial forest fire particulate matter could easily justify a lot of OC.

III.2.7.2.2 Sources of Organic Carbon

Despite this sampling site's fairly distant location south of where most of the forest fire activity was reported, the possibility of particulate matter collected at HRM-3 containing young carbon originating from this source cannot be ignored. However, lacking the substantial wind from the north that the 5 September sample had, the potassium level (0.421) is slightly lower than the previous day, suggesting less of an impact on this sample.

The evidence for cooking activity is low. Trace levels of magnesium (0.010%) and copper (0.003%) are even lower than the 5 September sample and, therefore, do not suggest charbroiling. Furthermore, amounts of barium (0..089%) and sodium (0.338%) show a very weak match with the standard SPECIATE profile and will not support the assumption of frying. A complete lack of aluminum discredits the option of including vegetative detritus.

III.2.7.2.3 Biogenic Fraction of Secondary Organic Aerosol

The sample contained 12 $\mu g/m^3$ organic carbon. Accounting for other sources of OC, such as fire activity (OC/potassium ratio of 82.939), and assuming that fossil organic carbon is associated with the fossil elemental carbon (0.832 $\mu g/m^3$ multiplied by 1.2), the OC from SOA is estimated to be: $12 - (0.832)(1.2) - (0.157)(82.939) = \mathbf{0\ \mu g/m^3}$. If the assumption of forest fire activity impacting this sample is incorrect, the SOA may be as high as 11.002 $\mu g/m^3$, a very large value. Unfortunately, ozone data were not available.

III.2.7.3 *7 September 2000*

III.2.7.3.1 General

This sample was a six-hour sample taken from 0600-1200 on a Thursday. The average temperature was 84.417 °F with a high of 90.7 °F at 1200. The average wind speed was 7.450 mph with a high of 7.1 mph at 1200. The wind was blowing from the northeast for the entire sampling period. The EC/TC ratio was 0.072 and the OC/EC ratio was 12.815. These values are a slight decrease from the 6 September sample. However, a fairly substantial source of organic carbon needs to be accounted for again.

III.2.7.3.2 Sources of Organic Carbon

As stated previously for the 5 and 6 September samples, the possibility of particulate matter collected at HRM-3 containing young carbon originating from this source cannot be ignored. Fair winds from the north/northeast were present, and the potassium level (0.622) is high enough to suggest agreement with the standard SPECIATE profile.

The evidence for cooking activity is slightly better than the 6 September sample. The complete absence of magnesium rules out the option of considering charbroiling, but the amounts of barium (0.139%) and sodium (0.691%) matched against the standard SPECIATE profile make frying difficult to ignore. The near absence of aluminum (0.003%) discredits the option of including vegetative detritus.

III.2.7.3.3 Biogenic Fraction of Secondary Organic Aerosol

The sample contained 6.1 μg/m^3 organic carbon. Accounting for other sources of OC, such as fire activity (OC/potassium ratio of 82.939) and cooking (OC/barium ratio of 124.783), and assuming that fossil organic carbon is associated with the fossil elemental carbon (0.476 μg/m^3 multiplied by 1.2), the OC from SOA is estimated to be: 6.1 – (0.476)(1.2) – (0.0835)(82.939) - (0.0186)(124.783) = **0 μg/m^3**. If the assumption of forest fire activity impacting this sample is incorrect, the SOA may be as high as 3.208 μg/m^3. Reducing the factor (82.939) used to include fire activity may increase its plausibility. Unfortunately, ozone data were not available.

III.2.7.4 *8 September 2000*

III.2.7.4.1 General

This sample was a 24-hour sample taken from 2400-2400 on a Friday. The average temperature was 78.767 °F with a high of 86.2 °F at 1400. The average wind speed was 5.088 mph with a high of 7.2 mph at 1100. The wind was blowing from the northeast for the entire day. The EC/TC ratio was 0.067 and the OC/EC ratio was 13.993. These values seem consistent with the previous two days. However, in sharp contrast, the amount of organic carbon collected on the filter sample was substantially less.

III.2.7.4.2 Sources of Organic Carbon

For the first time in several days, the effect of the forest fire activity shows strong signs of dissipation in this sample. Despite a wind pattern similar to the 5, 6, and 7 September samples, the amount of loading of organic carbon

seems quite small for a full 24-hour sample. Even the potassium level (0.310%) drops to a questionable match with the standard SPECIATE profile.

The evidence for cooking activity is very similar to the 7 September sample. The complete absence of magnesium rules out the option of considering charbroiling, but the amounts of barium (0.220%) and sodium (0.743%) matched against the standard SPECIATE profile make frying difficult to ignore. The near absence of aluminum (0.004%) discredits the option of including vegetative detritus.

III.2.7.4.3 Biogenic Fraction of Secondary Organic Aerosol

The sample contained 3.89 $\mu g/m^3$ organic carbon. Accounting for other sources of OC, such as cooking (OC/barium ratio of 124.783), and assuming that fossil organic carbon is associated with the fossil elemental carbon (0.278 $\mu g/m^3$ multiplied by 1.2), the OC from SOA is estimated to be: 3.89 – (0.278)(1.2) - (0.0262)(124.783) = **0.287 $\mu g/m^3$**. This SOA value seems reasonable. Given the fairly low average temperature, ozone levels were probably not that high that day, corresponding to low levels of SOA. Unfortunately, ozone data were not available.

III.2.7.5 ***13 September 2000***

III.2.7.5.1 General

This sample was a 24-hour sample taken from 2400-2400 on a Wednesday. The average temperature was 77.908 °F with a high of 81 °F at 1500. The average wind speed was 3.334 mph with a high of 7.7 mph at 0100. The wind was highly erratic throughout almost the entire day until around 1800

when it blew from the northeast for the remainder of the day. The EC/TC ratio was 0.201 and the OC/EC ratio was 3.983. These values appear to be much more consistent with a site located in the middle of a major industrial area.

III.2.7.5.2 Sources of Organic Carbon

Once again, almost all traces of forest fire activity seem to be removed. The organic carbon loading is low again, and the potassium level (0.191%) drops to a very poor match with the standard SPECIATE profile. The evidence for cooking activity is fairly strong. The magnesium (0.018%) and copper (0.011%) levels render charbroiling possible, but probably not significant. The amounts of barium (0.283%) and sodium (1.808%) matched against the standard SPECIATE profile make quite a strong case for frying. The complete absence of aluminum discredits the option of including vegetative detritus.

III.2.7.5.3 Biogenic Fraction of Secondary Organic Aerosol

The sample contained 2.88 $\mu g/m^3$ organic carbon. Accounting for other sources of OC, such as cooking (OC/barium ratio of 124.783), and assuming that fossil organic carbon is associated with the fossil elemental carbon (0.723 $\mu g/m^3$ multiplied by 1.2), the OC from SOA is estimated to be: 2.88 – (0.723)(1.2) - (0.026)(124.783) = **0 $\mu g/m^3$**. An SOA value of zero is not that difficult to accept in this case. Ozone levels were almost non-existent that day with a 24-hour average of 7.1 ppb and a maximum value of 26 ppb. Also, almost the entire quantity of OC collected on the filter can be attributed to cooking for this particular sample.

III.2.7.6 HRM-3 Summary

Table III-3 displays some of the data for all five sampling periods discussed in this section.

Table III-3 HRM-3 summary

DATE	DAY	TYPE	TEMP Avg (°F)	WIND Avg (mph)	OC/EC	SOA ($\mu g/m^3$)
5 Sep	Tue	6-HR	99.467	4.467	7.590	0
6 Sep	Wed	24-HR	88.65	3.967	14.423	0
7 Sep	Thu	6-HR	84.417	7.45	12.815	0
8 Sep	Fri	24-HR	78.767	5.088	13.993	0.287
13 Sep	Wed	24-HR	77.908	3.334	3.983	0

HRM-3 is by far the most complex site to analyze in this situation for several reasons. Initial logic suggests that since this site is located within close proximity of the Houston ship channel, a major industrial complex, that large amounts of fossil carbon would be collected on filter samples and that particulate matter of biogenic origin would be virtually non-existent. However, the forest fire activity that occurred north/northeast of Houston toward the end of August, beginning of September 2000, may have had an impact on samples collected within that timeframe. Unusually large amounts of organic carbon, and thus high OC/EC ratios, would seem to support this assertion. VOC data from the nearby Clinton site may complicate matters further. Anthropogenic isoprene may lead to SOA, which may lead to particulate matter, which appears to be biogenic in origin.

Regardless of the fact that the method used in this section to determine SOA led to zero values for four out of the five samples, a qualitative comparison of biogenic fraction among the samples may still be possible. A ranking of highest biogenic fraction to lowest might be: 1) 6 September (highest OC/EC ratio and strong evidence of forest fire particulate matter),
2) 7 September (next highest OC/EC ratio with strong evidence of fire PM),
3) 5 September (third highest OC/EC ratio with strong evidence of fire PM),
4) 8 September (actually second highest OC/EC ratio, but very little OC loading, and weak evidence of forest fire particulate matter), and
5) 13 September (absolute lowest OC/EC ratio and essentially no evidence of forest fire particulate matter). The actual order of the samples collected on 5, 6, and 7 September could certainly vary, but the fact that the biogenic fraction for all three of those samples is probably higher than the 8 and 13 September samples will not change.

III.3 ^{14}C OBSERVATIONS

III.3.1 Preliminary ^{14}C Data

Out of the twenty-three samples, plus two blanks, selected for ^{14}C measurements. Only the nine Aldine samples and two of the Conroe samples have been completed by NIST at this time. The data are presented in Table III-4.

Table III-4 ^{14}C data

SITE	DATE	% BIOGENIC	UNCERTAINTY
Aldine	9 August	33	2
Aldine	12 August	55	4
Aldine	13 August	68	1
Aldine	14 August	50	10
Aldine	15 August	25	2
Aldine	18 August	46	4
Aldine	19 August	57	2
Aldine	23 August	57	1
Aldine	25 August	37	2
Conroe	9 August	41	2
Conroe	13 August	72	4

III.3.2 Analysis

Clearly, biogenic emissions play a crucial role as a source of particulate matter for the Aldine and Conroe sites. All eleven samples were taken prior to the forest fire event that occurred during the TEXAQS period. Very little evidence was found for vegetative detritus as a source of organic carbon in any of the samples for which trace metal data are available. Also, as previously discussed, little evidence of cooking emissions is seen in the trace metal analyses for the 18 and 19 August samples at Aldine, and only small contributions from cooking are expected for 25 August. Therefore, with the exception of accounting for the possibility of small amounts of young carbon

(^{14}C) produced by cooking activity, the remainder of the particulate matter must be attributed to secondary organic aerosol at Aldine and Conroe on these dates, and a significant portion of that SOA must be biogenic in origin. As mentioned previously, VOC data do not indicate the presence of significant levels of isoprene at Aldine, suggesting conifer trees provide substantial biogenic emissions. In the case of Conroe, there were several occasions during the TEXAQS period when large isoprene concentrations were detected by aircraft, in isolated regions, north of Houston in the vicinity of the sampling site. Therefore, isoprene emissions and other emissions from deciduous vegetation may be a source of biogenic SOA in isolated areas north of Houston.

III.4 COMPARISONS

Of the eleven samples that have biogenic fractions reported within Table III-4, only three (Aldine—18, 19 and 25 August) were discussed in the predictions section. The Aldine summary (Section III.2.4.4) stated that the 19 August sample would have the highest biogenic fraction, and that the 25 August sample would have the lowest. Table III-4 confirms this prediction with the 19 August sample being 57% (± 2%) biogenic, and the 25 August sample being 37% (± 2%) biogenic.

IV CONCLUSIONS

The primary goal of this thesis was to predict the amount of ^{14}C present within the canister (VOC) and filter (PM) samples taken as part of TEXAQS 2000 from five different sites in and around Houston, Texas. These predicted values were to be compared to actual results from a portion of the samples selected for ^{14}C measurement.

Due to many different factors, including a tremendous lack of ancillary data necessary for making adequate predictions, the main objective stated above was only truly achieved for three samples taken at the Aldine site in suburban Houston, Texas on 18, 19, and 25 August 2000. For this limited set, the predictions and observations were in strong agreement, describing qualitatively which samples were most likely to contain the highest and the lowest biogenic fractions.

In addition to the direct effort aimed at achieving the stated research goals, several other qualitative conclusions regarding source attribution may be reported here:

1) For those filter samples collected in late August and early September 2000, the contribution of particulate matter originating from forest fire activity to the north/northeast of Houston is likely to be substantial.
2) The anthropogenic source of meat cooking, especially frying, is not always a significant source of particulate matter containing organic carbon. However, there were several samples that cooking activity could not be ignored and had to be considered.
3) Vegetative detritus was never a significant source of particulate matter for the eleven samples that had elemental composition data.

4) Biogenic emissions of isoprene from deciduous, or broadleaf, trees are probably not a significant contributor of secondary organic aerosol, and therefore particulate matter, at any of the sites that were sampled at other than Conroe, north of Houston.
5) Secondary organic aerosol that cannot be attributed to any other source is probably biogenic in origin. Without measurable levels of isoprene, conifer emissions such as α-pinene, β-pinene, and sesquiterpenes may be responsible.

Despite what seems to be an obvious conclusion that biogenic emissions play a role in the formation of particulate matter via secondary organic aerosol, the exact significance, or to what level of importance, this process has for urban and/or regional atmospheric chemistry was not addressed within this thesis. However, more and more, major metropolitan areas, such as Houston located near the Sam Houston National Forest, are opting to investigate the impact of biogenic emissions when examining control strategies and/or modeling that address their air pollution concerns.

V RECOMMENDATIONS

With any project, this thesis has probably created more questions than it has answered. This work can be used as a basis for many other areas of research, and it contains some invaluable data sets for easy reference, to include, meteorological, ozone, and particulate matter data, for four out of the five sampling sites, for almost the entire TEXAQS period.

Some of the results of the various processes mentioned within the methodology section have yet to be reported, such as, VOC speciation data from the canister samples taken at all five sites, to include the Washburn Tunnel, and ^{14}C measurements for all of the quartz filter samples, not just the twenty-three selected for priority analysis. Both of these data sets could be invaluable for continuing this research or pursuing a completely different approach toward analyzing the contribution of biogenic emissions to atmospheric chemistry in and around Houston, Texas.

The single most interesting possibility for future research that has arisen as a direct consequence of the results section is the issue of secondary organic aerosol, that has no definite precursor, at a site such as Aldine. As stated previously, α-pinene, β-pinene, and sesquiterpenes could be biogenic emissions responsible for what appears to be a substantial biogenic fraction observed for the particulate matter. Measurements should be made to confirm or deny the presence of conifer emissions.

Lastly, as an aside, the fairly unique aspect of forest fire activity and its implication for urban and/or regional atmospheric chemistry should be examined more thoroughly. This thesis suggests the strong possibility that some of the samples collected for ^{14}C measurements actually contain particulate matter generated from forest fire activity.

VI APPENDIX

VI.1 VOC DATA

VI.1.1 VOC Sample Collection Information

VI.1.2 VOC Preliminary Results

VI.1.1 VOC Sample Collection Information

Run ID	Date	Start	Site	Op	Environmental Conditions During Sampling
1	08/01/00	02:15 PM	Aldine	DCS	partly cloudy; light breeze; mid to high 90's (deg F) (relatively clean air following rainstorm on previous evening)
2	08/10/00	12:00 PM	Aldine	KRL	sunny & clear; somewhat hazy; light to moderate breeze; low 90 s
3	08/12/00	12:00 PM	Aldine	KRL	sunny; low to moderate haze; very slight breeze; mid 90s
4	08/14/00	09:00 AM	Aldine	KRL	partly cloudy @ 9 am to mostly cloudy @11 am; moderate haze; light breeze @9 am to moderate breeze @1130 am ; mid 90's
5	08/14/00	12:30 PM	Aldine	KRL	mostly cloudy; light haze; moderate breeze; mid 90"s
6	08/14/00	09:00 PM	Aldine	KRL	mostly cloudy; light to moderate breeze; high 80's
7	08/14/00	09:00 PM	Aldine	KRL	mostly cloudy; light to moderate breeze; high 80's
8	08/16/00	12:00 PM	Aldine	KRL	partly cloudy; light to moderate to hazy; very light to light breeze; mid to high 90's
9	08/18/00	12:30 PM	Aldine	KRL	sunny; moderately hazy; light breeze; high 90's
10	08/20/00	12:00 PM	Aldine	KRL	partly cloudy; light to moderate haze; light breeze; low to mid 90's
11	08/22/00	09:20 AM	Aldine	KRL	partly cloudy to mostly overcast by 1115; mod to heavy haze (barely see downtown from hwy 610); light breeze; low to mid 90's
12	08/22/00	09:20 AM	Aldine	KRL	partly cloudy to mostly overcast by 1115; mod to heavy haze (barely see downtown from hwy 610); light breeze; low to mid 90's
13	08/22/00	12:40 PM	Aldine	KRL	overcast; light to moderate haze; light breeze;mid 90's; threatening rain (actually did rain in other parts of city)
14	08/22/00	09:00 PM	Aldine	KRL	mostly cloudy; light breeze; high 80's
15	08/24/00	12:00 PM	Aldine	KRL	mostly cloudy; mod haze; very light breeze; low to mid 90's; last 15-20 minutes of run was overcast w thunderstorm on its way
16	08/24/00	12:00 PM	Aldine	KRL	mostly cloudy; mod haze; very light breeze; low to mid 90's; last 15-20 minutes of run was overcast w thunderstorm on its way
17	08/26/00	09:00 AM	Aldine	KRL	sunny; very light haze (clearest I've seen downtown in a while); very light breeze; low to mid 90's
18	08/26/00	09:00 AM	Aldine	KRL	sunny; very light haze (clearest I've seen downtown in a while); very light breeze; low to mid 90's
19	08/26/00	12:30 PM	Aldine	KRL	partly cloudy; very light haze; very light to light breeze; low to mid 90's
20	08/26/00	09:00 PM	Aldine	KRL	clear; light to moderate breeze;high to mid 80's
21	08/26/00	09:00 PM	Aldine	KRL	clear; light to moderate breeze;high to mid 80's
22	08/28/00	12:00 PM	Aldine	KRL	partly cloudy; light haze; light breeze; mid 90's
23	08/28/00	12:00 PM	Aldine	KRL	partly cloudy; light haze; light breeze; mid 90's
24	08/29/00	03:15 PM	W.Tun*	KRL	Indoor; low 90's; no AC
25	08/31/00	03:00 PM	W.Tun*	KRL	Indoor; mid 90's
26	09/04/00	12:00 PM	HRM3	KRL	sunny; light haze,\; light to moderate breeze; mid to high 90's
27	09/04/00	09:15 PM	HRM3	KRL	clear; light breeze; high 80's; industrial smell
28	09/05/00	09:00 AM	HRM3	KRL	sunny; moderate haze; very light breeze; mid to high 90's
29	09/12/00	09:00 AM	HRM3	KRL	partly cloudy; light haze; very light breeze; low to mid 90's; not much smell (unusual for this site)
30	09/12/00	12:20 PM	HRM3	KRL	mostly cloudy; light haze; light breeze; high 90's; @1430-- light sprinkle; moderate breeze
31	09/12/00	12:20 PM	HRM3	KRL	mostly cloudy; light haze; light breeze; high 90's; @1430-- light sprinkle; moderate breeze
32	09/14/00	09:45 AM	Conroe	KRL	mostly cloudy; light haze; very light breeze; low to mid 90's
33	09/14/00	09:45 AM	Conroe	KRL	mostly cloudy; light haze; very light breeze; low to mid 90's

VI.1.1 VOC Sample Collection Information

Run ID	Sampler II	Canister II	Scrubber II	Time (mir	Pres @leak check (mT)	Guage Pres @3min ("Hg	Guage Pres @end (psi)	Rate @3mir (LPM)	Rate @end (LPM)	Comments
1	813024	927054	tx1	180	6	-12	35	0.462	0.462	No problems
2	813024	922283	tx1	184	4	-12	35	0.462	0.462	Comment C2
3	813024	922287	tx1	180	7	-12	35	0.462	0.462	No problems
4	813024	919756	tx1	180	8	-12	35	0.462	0.462	No problems
5	813024	922284	tx1	180	9	-12	35	0.462	0.462	No problems
6	813024	922276	tx1	180	7	-12	35	0.462	0.462	Comment C6
7	813022	922281	none	180	7	-26	26	0.462	0.462	No problems
8	813024	922275	tx1	180	7	-12	35	0.462	0.462	comment C8
9	813024	922277	tx1	180	8	-12	35	0.462	0.462	comment C9
10	813024	922282	tx1	180	7	-12	35	0.462	0.462	No problems
11	813024	919754	tx1	180	9	-12	35	0.462	0.462	No problems
12	813022	927052	none	180	6	-26	26	0.462	0.462	No problems
13	813024	922274	tx1	180	4	-12	35	0.462	0.462	No problems
14	813024	922279	tx1	180	9	-12	35	0.462	0.462	No problems
15	813024	3992	tx2	180	12	-11	34	0.462	0.462	No problems
16	813022	2072	none	180	6	-27	25	0.462	0.462	No problems
17	813024	3995	tx2	180	6	-11	35	0.462	0.462	No problems
18	813022	919752	none	180	6	-26	28	0.462	0.462	No problems
19	813024	3989	tx2	180	8	-12	35	0.462	0.462	No problems
20	813024	919755	tx2	180	7	-11	35	0.462	0.462	No problems
21	813022	919751	none	180	4	-26		0.462	0.462	No problems
22	813024	919757	tx2	180	8	-11	35	0.462	0.462	No problems
23	813022	2074	none	180	5	-27	28	0.462	0.462	No problems
24	813024	919753	tx2	180	5	-12	35	0.462	0.462	No problems
25	813024	3990	tx2	180	4	-12	35	0.462	0.462	No problems
26	813024	3993	tx2	180	5	-12	35	0.462	0.462	No problems
27	813024	2071	tx2	180	5	-12	35	0.462	0.462	No problems
28	813024	927051	tx2	180	6	-11	35	0.462	0.462	No problems
29	813024	922286	tx3	180	4	-12	35	0.462	0.462	No problems
30	813024	2073	tx3	180	4	-12	35	0.462	0.462	No problems
31	813022	927050	none	180	3	-26	26	0.462	0.462	No problems
32	813024	927054r	tx3	180	6	-12	35	0.462	0.462	No problems
33	813022	3994	none	180	3	-26	27	0.462	0.462	No problems

VI.1.1 VOC Sample Collection Information

* Washburn Tunnel

C2 Valve (on can) was very tight. Had to use pipe wrench; very difficult to open slowly when starting run. With 22 minutes remaining on run, without me knowing it, an electrician shut off power to the platform for 3-5 minutes.

C6 DCS (David Stiles of ManTech) found valve loose and probably leaking out sample when this sample arrived at ERC Annex; CO_2 looks good.

C8 Beginning to notice that the flow is weakening; pressure doesn't drop very much with all valves open. I'm wondering if purge tube filled with LiOH is clogging up somewhat.

C9 I was right on about the extra LiOH in the purge tube (take it off and everything runs like normal). Made this run with it on anyway (might hurt purge cycle); sort of fixed it afterward.

VI.1.2 VOC Preliminary Results

Run ID	CO2 Scrubbed		CO2 Unscrubbed		T012		T012	CO2
	mean (ppb)	sdm (ppb)	mean (ppm)	sdm (ppm)	mean (ppb)	sdm (ppb)	scr./dir.	per total C
1	34	6			106	5		0.24
2	105	6			1420	7		0.07
3	63	6			193	5		0.25
4	91	6			213	5		0.30
5	39	6			139	5		0.22
6	66	6			202	5	0.92	0.25
7			378	0.5	220	5		
8	75	6			96	5		0.44
9	41	6			103	5		0.28
10	81	6			64	5		0.56
11	75	6			150	5	0.97	0.33
12			357	0.5	154	5		
13	116	6			108	5		0.52
14	64	6			340	5		0.16
15	46	6			110	5	0.88	0.30
16			356	0.5	125	5		
17	56	6			109	5	0.92	0.34
18		6	360	0.5	118	5		
19	964	6			123	5		
20	24	6			99	5	0.85	0.19
21			360	0.5	116	5		
22	120	6			72	5	0.82	0.62
23			350	0.5	88	5		
24	136	6			4127	27		0.03
25	163	6			4384	27		0.04
26	37	6			177	5		0.17
27	150	6			483	7		0.24
28	22	6			272	5		0.08
29	194	6			327	5		0.37
30	141	6			245	5	0.82	0.37
31			363	0.5	298	5		
32	27	6			89	5	0.80	0.23
33			368	0.5	111	5		
mean	82 **		361		454		0.87	0.27 **
stan dev	49 **		8		1009		0.06	0.15 **

**without run 19

VI.2 PM DATA

VI.2.1 PM Sample Collection Information

VI.2.2 PM Preliminary Results

VI.2.1 PM Sample Collection Information

SITE	ID #	DATE	TIME	DURATION	ENVIRONMENTAL CONDITIONS DURING SAMPLING
				(min)	
Aldine	01	August 8	0600	360	mostly cloudy; very light breeze; high 80s-low 90s; couldn't process sample until 1400 because of thunderstorm activity
Aldine	02	August 9	0000	1440	partly cloudy; very light breeze; low 90s; couldn't process sample until 0115
Aldine	03	August 10	0600	360	clear and sunny but moderately hazy; light breeze; low 90s
Aldine	04	August 10	1220	~300	clear and sunny but moderately hazy; light to moderate breeze; mid 90s; electrician shut off power for ~1 hour 1630-1730
Aldine	04	August 10	1220	~300	clear and sunny but moderately hazy; light to moderate breeze; mid 90s; electrician shut off power for ~1 hour 1630-1730
Aldine	05	August 11	0000	1440	@1130 partly cloudy; moderately hazy; very light breeze; mid 90s; @1900-2100 thuderstorm activity; @2100-2200 light rain
Aldine	06	August 12	0600	360	sunny; light to moderate haze; very light breeze; low 90s
Aldine	07	August 12	1215	360	sunny; light to moderate haze; very light breeze; low 90s
Aldine	07	August 12	1215	360	sunny; light to moderate haze; very light breeze; low 90s
Aldine	08	August 13	0000	1440	@1400: sunny; light haze; light breeze; mid 90s
Aldine	08	August 13	0000	1440	@1400: sunny; light haze; light breeze; mid 90s
Aldine	09	August 14	0600	360	partly cloudy to mostly @1100; moderately hazy; light to moderate breeze @1130; mid 90s
Aldine	11	August 14	1820	330	mostly cloudy; light to moderate breeze; high 80s
Aldine	12	August 15	0015	1425	@1300: mostly cloudy
Aldine	13	August 16	0600	360	partly cloudy; light to moderate haze; very light breeze; mid 90s
Aldine	14	August 16	1215	360	partly cloudy; moderate to very hazy; very light to light breeze; mid to high 90s
Aldine	15	August 17	0000	1440	sunny; light haze; light breeze; mid to high 90s
Aldine	16	August 18	0600	360	sunny; moderate haze; light breeze; low to mid 90s
Aldine	17	August 18	1215	360	sunny; moderate haze; light breeze; high 90s
Aldine	18	August 19	0000	1440	@1250: sunny; moderate haze; very light breeze; high 90s
Aldine	19	August 20	0600	360	partly cloudy; light to moderate haze; light breeze; low 90s; filter lighter in color than most AM samples here
Aldine	20	August 20	1215	360	partly cloudy; light to moderate haze; very light breeze; mid to low 90s; filter lighter in color than morning sample
Aldine	21	August 20	1830	330	mostly cloudy; light breeze; high 80s
Aldine	22	August 21	0020	1420	@1340: partly cloudy; light haze; light breeze; mid 90s
Aldine	23	August 22	0600	360	mostly cloudy; moderate to heavy haze; light breeze; low 90s
Aldine	24	August 22	1215	360	overcast (1215-1530) to partly cloudy (1530-1815); light to moderate haze; light breeze; mid 90s; threatened rain but never delivered
Aldine	25	August 23	0000	1440	thunderstorm activity throughout the city but not here; overcast @1345; very light breeze
Aldine	26	August 24	0600	360	mostly cloudy; light to moderate haze; very light to light breeze; high 80s to low 90s
Aldine	27	August 24	1215	360	@1430: thunderstorm activity began; light rain on and off (heavy at one point); moderate breeze at one time; light rain from 1700 on; high 80s

VI.2.1 PM Sample Collection Information

SITE	ID #	DATE	TIME	DURATION	ENVIRONMENTAL CONDITIONS DURING SAMPLING
Aldine	28	August 25	0000	1440	@1834: partly cloudy; light haze; light breeze; high 80s
Aldine	29	August 26	0600	360	sunny; very light haze (clearest I've seen downtown in a while); very light breeze; high 80s to low 90s
Aldine	30	August 26	1215	360	partly cloudy; light haze; light breeze; mid to high 90s
Aldine	31	August 26	1830	330	clear; light to moderate breeze; high to mid 80s
Aldine	32	August 27	0015	1425	@1000: partly cloudy; very light haze; light breeze; low 90s
Aldine	33	August 28	0600	360	partly cloudy; light haze; light to moderate breeze; low to mid 90s
Aldine	34	August 28	1215	360	partly cloudy; light haze; light breeze; mid to low 90s
Aldine	34	August 28	1215	360	partly cloudy; light haze; light breeze; mid to low 90s
Aldine	35	August 29	0000	1440	mostly clear; hot; upper 90s; light winds; light haze
Aldine	36	August 30	0600	360	clear; hot; 100s today; light winds; haze
Aldine	36	August 30	0600	360	clear; hot; 100s today; light winds; haze
Aldine	37	August 30	1215	360	clear; very hot (~100); light winds; haze
Aldine	38	August 31	0000	720	partly cloudy; light to moderate haze; light breeze; low to mid 90s
Conroe	01	August 8	0600	360	mostly cloudy; almost no breeze; low 90s
Conroe	02	August 8	1215	360	almost overcast most of the sampling period; some thunderstorm activity; high 80s; no breeze
Conroe	03	August 9	0000	1440	@1100: partly cloudy; very light breeze; low 90s
Conroe	04	August 11	0600	360	scattered clouds; light haze; light breeze; low 90s
Conroe	05	August 11	1250	360	partly to mostly cloudy; light haze; very light breeze; mid 90s
Conroe	05	August 11	1250	360	partly to mostly cloudy; light haze; very light breeze; mid 90s
Conroe	06	August 13	0600	360	sunny; almost no haze; light breeze; low 90s
Conroe	07	August 13	1215	360	sunny; almost no haze; light breeze; mid 90s
Conroe	08	August 27	0600	360	partly cloudy; light haze; light breeze; high 80s to low 90s
Conroe	09	August 27	1215	360	partly cloudy; light haze; light to moderate breeze; mid to low 90s
Conroe	10	August 29	0600	360	sunny; light haze; light breeze; low to mid 90s
Conroe	11	August 30	0000	1440	unknown--in Austin all day
Conroe	12	August 31	0600	360	partly cloudy; light haze; light breeze; low to mid 90s
Conroe	12	August 31	0600	360	partly cloudy; light haze; light breeze; low to mid 90s

VI.2.1 PM Sample Collection Information

SITE	ID #	DATE	TIME	DURATION	ENVIRONMENTAL CONDITIONS DURING SAMPLING
Galvest	01	August 20	0000	1440	@1000: mostly cloudy; light haze; light breeze; high 80s; couldn't process sample until 0140
Galvest	02	August 21	0600	360	mostly cloudy; light haze; light breeze; low 90s
Galvest	03	August 21	1215	360	mostly cloudy; light haze; light breeze; mid 90s
Galvest	03	August 21	1215	360	mostly cloudy; light haze; light breeze; mid 90s
Galvest	04	August 22	0000	1440	@1400: mostly cloudy; light haze; light to moderate breeze; mid 90s; threatened rain at one point
Galvest	05	August 23	0600	360	thunderstorm activity with showers all morning; light breeze; low 90s
Galvest	06	August 23	1215	360	mostly cloudy; light haze; light to moderate breeze; high 80s
Galvest	07	August 24	0000	1440	@0930: mostly cloudy; light haze; very light breeze; high 80s; thunderstorm activity up north @ Aldine but not sure how it impacted Galveston
Galvest	08	August 25	0600	360	partly cloudy; light haze; light breeze; high 80s
HRM3	01	August 15	0600	360	mostly cloudy; moderate haze; light breeze; low 90s; industrial smell
HRM3	02	August 15	1215	360	mostly cloudy; modetate haze; light breeze; low 90s; couldn't process sample until 2300
HRM3	03	August 17	0600	360	very sunny; light haze; light breeze; industrial smell
HRM3	04	August 17	1215	360	sunny; light haze; light breeze; industrial smell
HRM3	04	August 17	1215	360	sunny; light haze; light breeze; industrial smell
HRM3	05	August 18	0000	1440	@1300: sunny; moderate haze; light breeze; high 90s; industrial smell
HRM3	06	August 19	0600	360	sunny; moderate haze; can't see downtown very well from surrounding highways; very light breeze; mid 90s; smell doesn't seem quite as bad
HRM3	07	August 19	1215	360	sunny; moderate to heavy haze; light to moderate breeze; high 90s
HRM3	08	Sept. 2	0600	360	unknown
HRM3	09	Sept. 5	0600	360	sunny; light to moderate haze; very light breeze; mid to high 90s
HRM3	10	Sept. 5	1215	360	sunny; moderate haze; light breeze; high 90s to low 100s
HRM3	11	Sept. 6	0000	1440	unknown--heavy haze I'm told from forest fire activity to the northeast
HRM3	12	Sept. 7	0600	360	sunny; moderate haze; light breeze; high 80s to low 90s
HRM3	12	Sept. 7	0600	360	sunny; moderate haze; light breeze; high 80s to low 90s
HRM3	12	Sept. 7	0600	360	sunny; moderate haze; light breeze; high 80s to low 90s
HRM3	12	Sept. 7	0600	360	sunny; moderate haze; light breeze; high 80s to low 90s
HRM3	13	Sept. 7	1215	360	mostly clear; moderate winds from the northeast; mid 90s
HRM3	14	Sept. 8	0012	1427	mostly cloudy; high 80s; light showers after 2000; southeasterly maritime flow
HRM3	15	Sept. 12	0600	360	partly cloudy; light haze; very light breeze; low to mid 90s; not much smell for this site

VI.2.1 PM Sample Collection Information

SITE	ID #	DATE	TIME	DURATION	ENVIRONMENTAL CONDITIONS DURING SAMPLING
HRM3	15	Sept. 12	0600	360	partly cloudy; light haze; very light breeze; low to mid 90s; not much smell for this site
HRM3	15	Sept. 12	0600	360	partly cloudy; light haze; very light breeze; low to mid 90s; not much smell for this site
HRM3	15	Sept. 12	0600	360	partly cloudy; light haze; very light breeze; low to mid 90s; not much smell for this site
HRM3	16	Sept. 13	0000	1440	unknown--however, thunderstorms passed through the area all day

VI.2.2 PM Preliminary Results

SITE	ID #	DATE	TIME	DURATION (min)		OC (ug/cm2)	OC err (ug/cm2)	EC (ug/cm2)	EC err (ug/cm2)	Total (ug/cm2)	TC err (ug/cm2)	EC/TC ratio
Aldine	01	August 8	0600	360		6.26	0.51	1.86	0.29	8.11	0.71	0.23
Aldine	02	August 9	0000	1440		17.30	1.06	5.67	0.48	22.97	1.45	0.25
Aldine	03	August 10	0600	360		6.90	0.55	2.94	0.35	9.84	0.79	0.30
Aldine	04	August 10	1220	~300		6.59	0.53	0.87	0.24	7.47	0.67	0.12
Aldine	04	August 10	1220	~300	Duplicate	6.65	0.53	0.89	0.24	7.53	0.68	0.12
Aldine	05	August 11	0000	1440		15.06	0.95	2.17	0.31	17.23	1.16	0.13
Aldine	06	August 12	0600	360		9.71	0.69	1.16	0.26	10.87	0.84	0.11
Aldine	07	August 12	1215	360		8.32	0.62	0.50	0.22	8.82	0.74	0.06
Aldine	07	August 12	1215	360	Duplicate	8.57	0.63	0.42	0.22	8.99	0.75	0.05
Aldine	08	August 13	0000	1440		42.20	2.31	2.63	0.33	44.83	2.54	0.06
Aldine	08	August 13	0000	1440	Duplicate	41.23	2.26	2.75	0.34	43.98	2.50	0.06
Aldine	09	August 14	0600	360		9.91	0.70	1.57	0.28	11.48	0.87	0.14
Aldine	11	August 14	1820	330		4.77	0.44	0.68	0.23	5.45	0.57	0.12
Aldine	12	August 15	0015	1425		14.98	0.95	5.72	0.49	20.71	1.34	0.28
Aldine	13	August 16	0600	360		5.05	0.45	1.62	0.28	6.67	0.63	0.24
Aldine	14	August 16	1215	360		6.84	0.54	0.66	0.23	7.50	0.67	0.09
Aldine	15	August 17	0000	1440		19.55	1.18	2.22	0.31	21.76	1.39	0.10
Aldine	16	August 18	0600	360		6.56	0.53	1.88	0.29	8.44	0.72	0.22
Aldine	17	August 18	1215	360		11.37	0.77	1.07	0.25	12.44	0.92	0.09
Aldine	18	August 19	0000	1440		26.97	1.55	2.44	0.32	29.41	1.77	0.08
Aldine	19	August 20	0600	360		6.54	0.53	1.13	0.26	7.67	0.68	0.15
Aldine	20	August 20	1215	360		7.98	0.60	0.47	0.22	8.45	0.72	0.06
Aldine	21	August 20	1830	330		4.43	0.42	0.67	0.23	5.10	0.56	0.13
Aldine	22	August 21	0020	1420		19.96	1.20	2.46	0.32	22.42	1.42	0.11
Aldine	23	August 22	0600	360		7.67	0.58	2.01	0.30	9.68	0.78	0.21
Aldine	24	August 22	1215	360		6.49	0.52	0.73	0.24	7.21	0.66	0.10
Aldine	25	August 23	0000	1440		27.41	1.57	3.26	0.36	30.68	1.83	0.11
Aldine	26	August 24	0600	360		7.76	0.59	1.95	0.30	9.72	0.79	0.20
Aldine	27	August 24	1215	360		5.62	0.48	1.18	0.26	6.80	0.64	0.17
Aldine	28	August 25	0000	1440		18.53	1.13	3.89	0.39	22.42	1.42	0.17
Aldine	29	August 26	0600	360		4.39	0.42	1.22	0.26	5.61	0.58	0.22
Aldine	30	August 26	1215	360		6.55	0.53	0.75	0.24	7.30	0.66	0.10
Aldine	31	August 26	1830	330		3.34	0.37	0.38	0.22	3.72	0.49	0.10
Aldine	32	August 27	0015	1425		8.63	0.63	1.66	0.28	10.29	0.81	0.16
Aldine	33	August 28	0600	360		4.87	0.44	1.80	0.29	6.67	0.63	0.27
Aldine	34	August 28	1215	360		6.73	0.54	0.77	0.24	7.50	0.68	0.10
Aldine	34	August 28	1215	360	Duplicate	6.74	0.54	0.78	0.24	7.53	0.68	0.10
Aldine	35	August 29	0000	1440		15.06	0.95	2.24	0.31	17.31	1.17	0.13
Aldine	36	August 30	0600	360		3.71	0.39	0.91	0.25	4.62	0.53	0.20
Aldine	36	August 30	0600	360	Duplicate	3.70	0.39	0.93	0.25	4.63	0.53	0.20
Aldine	37	August 30	1215	360		6.58	0.53	0.55	0.23	7.13	0.66	0.08

VI.2.2 PM Preliminary Results

SITE	ID #	DATE	TIME	DURATION		OC	OC err	EC	EC err	Total	TC err	EC/TC ratio
				(min)		(ug/cm2)	(ug/cm2)	(ug/cm2)	(ug/cm2)	(ug/cm2)	(ug/cm2)	
Aldine	38	August 31	0000	720		8.52	0.63	1.32	0.27	9.84	0.79	0.13
Conroe	01	August 8	0600	360		6.94	0.55	0.69	0.23	7.63	0.68	0.09
Conroe	02	August 8	1215	360		6.96	0.55	0.58	0.23	7.54	0.68	0.08
Conroe	03	August 9	0000	1440		18.42	1.12	3.20	0.36	21.62	1.38	0.15
Conroe	04	August 11	0600	360		4.07	0.40	0.33	0.22	4.40	0.52	0.07
Conroe	05	August 11	1250	360		8.75	0.64	0.30	0.21	9.04	0.75	0.03
Conroe	05	August 11	1250	360	Duplicate	8.71	0.64	0.23	0.21	8.94	0.75	0.03
Conroe	06	August 13	0600	360		12.69	0.83	0.58	0.23	13.27	0.96	0.04
Conroe	07	August 13	1215	360		10.60	0.73	0.34	0.22	10.94	0.85	0.03
Conroe	08	August 27	0600	360		4.81	0.44	0.53	0.23	5.34	0.57	0.10
Conroe	09	August 27	1215	360		6.89	0.54	0.35	0.22	7.24	0.66	0.05
Conroe	10	August 29	0600	360		4.81	0.44	0.96	0.25	5.77	0.59	0.17
Conroe	11	August 30	0000	1440		15.43	0.97	1.27	0.26	16.71	1.14	0.08
Conroe	12	August 31	0600	360		6.44	0.52	0.87	0.24	7.30	0.67	0.12
Conroe	12	August 31	0600	360	Duplicate	6.69	0.53	0.89	0.24	7.58	0.68	0.12
Galvest	01	August 20	0000	1440		9.27	0.66	0.99	0.25	10.25	0.81	0.10
Galvest	02	August 21	0600	360		3.66	0.38	0.40	0.22	4.06	0.50	0.10
Galvest	03	August 21	1215	360		4.66	0.43	0.54	0.23	5.20	0.56	0.10
Galvest	03	August 21	1215	360	Duplicate	4.75	0.44	0.60	0.23	5.35	0.57	0.11
Galvest	04	August 22	0000	1440		15.13	0.96	1.50	0.27	16.62	1.13	0.09
Galvest	05	August 23	0600	360		3.70	0.39	0.55	0.23	4.25	0.51	0.13
Galvest	06	August 23	1215	360		4.69	0.43	0.67	0.23	5.36	0.57	0.13
Galvest	07	August 24	0000	1440		5.96	0.50	0.79	0.24	6.75	0.64	0.12
Galvest	08	August 25	0600	360		3.86	0.39	0.78	0.24	4.64	0.53	0.17
HRM3	01	August 15	0600	360		5.00	0.45	1.85	0.29	6.85	0.64	0.27
HRM3	02	August 15	1215	360		6.22	0.51	0.91	0.25	7.14	0.66	0.13
HRM3	03	August 17	0600	360		1.07	0.25	0.01	0.20	1.07	0.35	0.01
HRM3	04	August 17	1215	360		10.84	0.74	1.07	0.25	11.91	0.90	0.09
HRM3	04	August 17	1215	360	Duplicate	10.50	0.72	1.07	0.25	11.57	0.88	0.09
HRM3	05	August 18	0000	1440		24.21	1.41	4.09	0.40	28.29	1.71	0.14
HRM3	06	August 19	0600	360		11.95	0.80	1.50	0.28	13.45	0.97	0.11
HRM3	07	August 19	1215	360		10.77	0.74	0.75	0.24	11.52	0.86	0.07
HRM3	08	Sept. 2	0600	360		6.09	0.50	0.80	0.24	6.89	0.64	0.12
HRM3	09	Sept. 5	0600	360		10.24	0.71	2.74	0.34	12.98	0.95	0.21
HRM3	10	Sept. 5	1215	360		12.21	0.81	1.31	0.27	13.52	0.98	0.10
HRM3	11	Sept. 6	0000	1440		45.59	2.48	4.02	0.40	49.61	2.78	0.08
HRM3	12	Sept. 7	0600	360		4.89	0.44	0.90	0.25	5.80	0.59	0.16
HRM3	12	Sept. 7	0600	360	Duplicate	4.74	0.44	0.96	0.25	5.70	0.59	0.17

VI.2.2 PM Preliminary Results

SITE	ID #	DATE	TIME	DURATION		OC	OC err	EC	EC err	Total	TC err	EC/TC ratio
				(min)		(ug/cm2)	(ug/cm2)	(ug/cm2)	(ug/cm2)	(ug/cm2)	(ug/cm2)	
HRM3	12	Sept. 7	0600	360	Backup	1.11	0.26	0.00	0.20	1.12	0.36	0.00
HRM3	12	Sept. 7	0600	360	Backup Dup.	1.03	0.25	-0.02	0.20	1.01	0.35	-0.02
HRM3	13	Sept. 7	1215	360		20.99	1.25	1.24	0.26	22.23	1.41	0.06
HRM3	14	Sept. 8	0012	1427		16.85	1.04	1.62	0.28	18.46	1.22	0.09
HRM3	15	Sept. 12	0600	360		4.61	0.43	0.96	0.25	5.57	0.58	0.17
HRM3	15	Sept. 12	0600	360	Duplicate	4.48	0.42	1.16	0.26	5.65	0.58	0.21
HRM3	15	Sept. 12	0600	360	Backup	1.01	0.25	0.03	0.20	1.04	0.35	0.03
HRM3	15	Sept. 12	0600	360	Backup Dup.	0.99	0.25	0.02	0.20	1.01	0.35	0.02
HRM3	16	Sept. 13	0000	1440		15.98	1.00	3.95	0.40	19.93	1.30	0.20

VI.3 TNRCC DATA--ALDINE

VI.3.1 Temperature Data (°F)--Aldine

VI.3.2 Wind Speed Data (mph)--Aldine

VI.3.3 Wind Direction (0-359 degrees)--Aldine

VI.3.4 Ozone (ppb)--Aldine

VI.3.1 Temperature Data (°F)--Aldine

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	79.9	80	80.1	76.6	80	77.9	81.3	76.7	80.5	78.9	81	79.5	79.7	77.4	80.1	80.3	78.7	77.3
100	78.8	79.6	79.2	75.3	79.2	77.2	79.9	75.8	80.1	77.8	79.8	78	77.7	76.1	77.9	79	78.1	76.6
200	77.6	78.4	78	75.7	78.6	77.2	78.6	75.4	79.6	77.8	78.7	77	76.6	75.4	77.2	78.4	77.6	76.7
300	77.2	78	76.7	75	77.8	76.6	77.3	75.8	78.9	76.9	78.2	76.4	75.3	74.6	77.5	78.1	76.9	76
400	76.7	78.2	76	74.5	77.5	75.6	76.7	75.9	79.2	75.7	77.6	75.4	74.3	73.8	77.1	78.1	76.1	75.8
500	75.7	78.5	75.8	73.9	76.9	75.3	75.5	75.2	78.6	75.9	77	74.7	74	73.2	76.7	77.7	75.6	75.4
600	76.9	79.5	76.7	74.7	77.2	75.9	75.6	76.5	79.4	76.8	77.3	75.3	73.7	74	77.2	77.9	75	75.9
700	81	82.9	81.1	78.1	79.1	78.5	79	80	82.6	79.7	79.9	78.8	77.8	78.3	80.2	80	76.7	78.9
800	84.2	85.3	83.8	81.2	81.9	81.5	82.8	84.9	85	82.6	83	82.4	81.6	81.6	82.9	82.9	81.9	82.2
900	85.8	87.5	86.9	84.3	84.9	84.8	86.2	87.7	86.9	85.1	85.7	85.2	85	84	85.5	84.8	83.2	84.7
1000	88	90	88.6	87	88	87.6	90.5	89.3	89.1	87.5	88.6	87.7	87.8	87.3	88.1	86.5	82.2	86.8
1100	89.9	**91.2**	90.2	89.6	90.8	90.2	93.2	91	89.5	89.6	91.9	90.2	90	90	91.2	83.8	79.4	89.1
1200	89.7	85.8	92.7	91.6	92.7	92.8	95	91.5	90.2	91.8	94.5	92.6	92.3	92.1	93.4	79.9	80.8	**91.2**
1300	91.1	82.5	**93.3**	93.4	94.4	94.5	**96.7**	92.3	91.5	94	96.3	94.5	94	94.2	95.1	81.4	82.6	90.2
1400	91.7	80.8	92.9	94.7	96	95.6	96.7	**92.4**	92.7	95.9	96.5	95.7	95.6	95.2	95.4	83.7	84	78.9
1500	**91.8**	81.4	91.6	96.1	97.5	**96.8**	96.5	91.6	93.2	97.1	**96.8**	**96.7**	**96.3**	**96.6**	**96.4**	85.9	84.7	77.2
1600	91.2	82.6	91.4	**96.6**	**97.7**	96.6	95.5	91.2	**93.4**	**97.6**	96.7	96.2	94.4	96.3	95.7	87.9	**85.1**	77.9
1700	90.3	83.7	90.9	94.5	97	96	93.3	89.9	91.9	97.5	95.2	94.3	92.8	93.3	93.5	**88.5**	84.5	77.7
1800	88.1	83.9	88.6	92.3	84.8	94.1	90.1	87.7	89.2	93.2	92.7	91.7	90	90.3	89.8	87.3	83.7	77.7
1900	85.4	83.1	85.2	88.8	82.9	91.2	86.6	85.7	86.3	89.1	89.5	87.8	86.5	87	86.7	84.8	82.5	77.6
2000	84.1	82.2	82.6	86.1	81.2	88.1	84.6	84.3	84.4	87.1	85.9	85.1	83.5	84.5	84.8	83.2	81.5	76.9
2100	83.1	81.4	81.3	84.3	80.1	86.1	82.4	83.8	82.8	87.2	83.6	82.5	81.9	82.9	83.8	81.8	80.4	76.3
2200	82	80.9	79.6	83	80.4	83.7	80.5	82.4	81.5	84.9	82.4	80.8	80.4	81.8	82.6	80.6	79.1	76
2300	81	80.7	78.2	81.3	79	82.2	77.5	81.1	79.8	83	80.9	80.1	78.7	81	81	79.5	77.9	75.4

VI.3.1 Temperature Data (°F)—Aldine

	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
TIME																		
0	75	78.1	78.2	79.5	79	79.7	83.7	85.9	77.4	84.4	85.3	83.4	85.7	79.5	74.2	75.8	77.8	78.3
100	74.6	77.1	77.5	78.5	77.6	78.4	82.4	84.2	77.9	83.3	83.2	81.4	82.7	79	73.7	75.6	77.3	77.8
200	74.2	76.1	75.9	78.1	76.5	77.6	80.9	83.1	77.8	81.9	81.1	80.5	80.2	78.2	72.8	75.7	77	77
300	73.9	75.7	75.5	77	75.3	76.9	79.3	81.8	77.9	81.1	80.4	80.1	77.7	76.7	72.4	75.7	76.5	76.6
400	73.8	74.3	74.9	76.2	74.9	76.2	79	81	77.6	80.2	80.8	79	75.7	76	72	75.8	76.4	76.8
500	74.2	74.3	74.8	75.9	74.8	76.7	77.7	80.7	77.6	79.2	79.4	78.8	74.3	75.1	72.3	75.6	76.4	76.2
600	73.9	74.3	75.4	76.4	75.9	77.2	78.1	80.6	78.8	78.9	78.7	78.9	73.3	74.3	72.5	75.2	76.1	77.3
700	76.8	78.8	79.2	80.2	79.5	79.2	81.4	83.2	82.4	81.6	81.9	83.8	74	76.6	73.1	76.1	79.7	80.2
800	80.7	81.7	83.4	83.9	83.2	82.2	86	85.9	84.9	84.5	87.2	87.8	76.3	79.3	74.2	77.3	83.4	83.5
900	83.5	85.3	86	87.3	86.4	85.3	90.4	89.6	87.7	88.4	92.9	92.1	79.5	81	76.6	80.2	84.5	83.8
1000	86.3	87.7	88.9	89.1	89.2	88.3	94.6	93	90.6	92	97.6	96.4	82.9	83.2	79.2	82.5	87.4	84.1
1100	88.5	90	91	91.2	91	91.8	98.7	97	94.3	95.7	101.3	100.3	86.3	86.6	81	85.1	89.3	85.9
1200	89.7	92.1	92.8	93.4	93.6	95	101.2	100.1	97.1	98.4	104.7	102.6	89.1	89.2	82.5	86.4	**91.6**	85.7
1300	91.4	93.3	**93.9**	95.1	95.7	98.1	102.5	102.1	98.9	100.3	106.4	104.2	90.8	91	85.4	85.4	87.8	85.5
1400	92.4	**94.6**	92.9	**95.3**	96.9	100.2	103.9	103.7	100.6	101.9	**106.8**	**104.6**	92.2	**91.5**	85.3	86.1	86.9	83.7
1500	**92.8**	94.2	92.8	94.7	**98.2**	101.3	104.5	**104.1**	101.6	102.8	106.4	104	93.2	91.1	**85.5**	**88.4**	87.6	88.2
1600	92.4	93.2	92.8	94.3	97.8	**102.1**	**104.7**	96.3	**102.1**	**103.2**	105.9	102	**93.8**	89.9	85	87.4	79.6	**89**
1700	90.8	91.7	91.3	92.7	94.5	101.4	103.3	81	95.2	102.8	103.8	101.3	93	87.8	83.4	85.8	81.8	88.4
1800	88.3	89.3	88.5	89.7	91	98	99.9	81.5	92.4	98.7	99.7	100	90.7	83.8	81.1	83.3	82.8	86.4
1900	85.8	86.3	85.9	86.5	87.7	92.7	95.6	85	91.2	96.3	96.3	96.9	88.1	81	79	81.2	82.6	83.9
2000	83.8	83.6	83.9	84	85.2	89.5	93.6	82.7	88.6	92.7	93	94.2	84.9	78.8	78.4	79.9	81.7	82.4
2100	82.3	81.8	82.3	82.5	83.5	88.1	91.8	81.7	86.6	90.7	90.8	92.1	84.3	77.1	76.5	79.6	80.4	81.2
2200	80.7	80.6	81	81.3	82.1	86.4	90.7	79.9	86.3	87	88	89.9	83.2	75.7	75.8	78.8	79.5	79.8
2300	79.4	79.7	79.9	80.2	81	85.4	87.9	78.1	85.7	86.6	85.8	88.3	81.3	74.7	76.1	78.5	78.6	78.8

VI.3.1 Temperature Data (°F)—Aldine

TIME	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
0	77.6	75.2	77.4	74.3	75	65.6
100	76.8	75.6	76.8	73.9	72.5	65.2
200	76.6	75.2	76.2	74	71.1	63.8
300	77	75.2	75.5	74.2	70.6	62.5
400	76.7	75.2	75.1	74	67.4	61.4
500	77.3	75.3	74.8	73.9	66.4	61
600	77.8	75.3	74.8	73.9	65.9	60.9
700	80.5	75.3	76.1	76	67.7	63.8
800	83.7	75.7	79.3	79.5	71	69.1
900	86	76	82.7	82.5	73.6	73.7
1000	87.6	76.7	86.2	83.3	77.4	77.4
1100	89.1	76.4	**87.4**	85.3	80.4	80
1200	90.5	74.8	86.4	88.8	82.6	81.6
1300	**91.4**	74.5	80.9	90.9	84.6	83.9
1400	87.1	76.8	83.3	90.8	86.7	85.2
1500	90.3	**80.6**	86	91.5	87.6	86.5
1600	89.9	80.2	85.8	**91.7**	**87.8**	**87.1**
1700	88.1	79.5	80.3	90.8	86.6	86.3
1800	85.6	78.2	77	88.6	82	80.8
1900	82.9	77.6	77.2	85.8	76.7	74.8
2000	75.8	77.6	76.9	83.3	73.1	71.1
2100	75.5	77.5	76.2	81.3	69.8	68.2
2200	75.7	77.7	75.5	79.9	68.2	66.6
2300	75.7	77.6	74.6	77.4	65.7	63.9

VI.3.2 Wind Speed Data (mph)—Aldine

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	3.1	1.5	3.4	1.3	3.5	2.3	1.6	0.5	1.7	1.8	3.2	2.2	3	1.4	1.4	0.6	2	1.2
100	1.5	1	2.4	1.5	4.1	0.9	0.6	0.3	1.3	2.5	4.5	1.7	2.9	2.5	1.4	0.5	2.5	0.9
200	2.2	0.4	0.4	1.6	4.3	1	0.9	0.8	0.3	2.3	3.8	0.7	2.4	1.3	1.5	0.9	2.3	1.5
300	1.3	1.2	0.9	0.5	4.8	1	0.1	2.1	0.6	0.8	4.1	1.5	1	0.7	0.8	0.4	3.9	2.1
400	1.4	2	0.7	1.6	4.9	0.9	0.6	1.9	1.3	0.5	5.2	1	2.2	0.7	1.1	1.2	3.5	0.8
500	0.5	3.1	0.7	0.4	3	0.8	0.6	1.9	1.7	0.2	4.7	0.5	0.9	0.6	1.2	1.1	3.2	1.9
600	1.3	1.6	0.8	1.9	2.8	1.4	0.8	2.8	2	0.8	5.2	0.5	0.6	0.7	1.4	4.1	2.6	0.6
700	2.5	4	1.7	1.7	5.4	3.4	2.5	4.2	2.7	1.7	8	2.8	1.4	0.3	2.2	4.7	2.9	1.8
800	4.4	6.6	3.2	2.3	7.5	2.1	4	5.3	4.4	5.1	8.6	4.2	3.4	3.7	4.4	4.2	2.7	2.2
900	4.6	6.3	4.4	1.2	6.8	0.4	4.5	7.4	6	6.1	6.5	3.1	3.5	4.9	4.4	4.2	3.2	2
1000	5	5.5	2.9	1.9	3.2	2.2	5.7	7.8	5.3	4.7	5.2	1.4	2	5.5	1.5	4.6	5.2	3
1100	4.5	4.5	1.9	3.9	2	2.9	5.9	8.5	6.3	5.5	2.3	2.6	2.3	4.7	2.7	5.6	5.9	2.6
1200	5.9	**8.7**	3	2.8	2.7	3.5	6.7	8.6	7	2.9	2	3.2	2.5	3.4	2.7	2.9	3.9	3.2
1300	7.5	3.2	3.4	3.2	2.7	4.9	7.4	9.5	7.1	4.3	2.6	4.4	4.3	4.2	7.6	2.6	3.4	6.9
1400	7.9	3.7	5	4.2	2	1.6	8.1	10.9	9.9	1.9	3.9	4.3	2.7	3.6	6.4	5.1	4.3	**9.1**
1500	8.6	3.3	7.4	0.1	3.9	4.4	7.8	**11.3**	**10.8**	3.1	7.2	4.2	5.1	3.1	6.7	4.5	5.8	5.9
1600	**9.7**	2.7	6.7	4.7	4.5	4.2	**9.4**	11.3	8.1	3.1	7.4	8.3	8.7	5.8	8.3	**6.5**	**6.9**	4.9
1700	8.9	1.3	**8.5**	5.8	4.4	5	8.8	10.5	4.3	1.8	**8.9**	**9.1**	**8.8**	**9.2**	**10**	5.9	6.1	2.8
1800	8.6	2.3	7.3	5.6	**11.8**	4.6	7.1	10.1	5.3	5.8	8.5	6.5	7.4	8.5	9.5	5.8	4.8	1.8
1900	6.9	3.3	4.7	**5.8**	4.6	**6**	5.1	7.3	6.2	**7**	6.9	4.1	5.9	7	6.1	4.6	3.5	1.1
2000	6.7	5	3.6	4.8	3.8	4	4.5	4.7	6	4.9	6.2	5.7	6.1	5.5	4.6	3.7	1.9	0.7
2100	4.9	4.5	3.4	3.1	3.7	2.1	3.1	1.5	4.1	6.1	5.9	3.6	5	5.1	3.4	2.1	1.1	0.8
2200	1.8	5.3	2.1	4.4	2	2	1.9	2.5	1.9	4.8	5.5	3.9	3	4.1	1.6	2.2	1.6	0.8
2300	1.1	4.5	0.9	4.9	2.3	1.6	0.9	3	1.5	4	3.3	3.7	2.5	3	1.6	2.1	0.2	0.7

VI.3.2 Wind Speed Data (mph)—Aldine

TIME	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
0	0.1	2	2.2	2.6	1.6	2.4	4	4.6	1.5	6.9	3.6	0.4	7.6	1.4	6	5.4	2.9	2.2
100	0.6	0.7	1	1.5	1.2	1.8	5.7	3	1.4	6.2	2.2	1.1	6.8	4.8	5.3	3.6	2.1	1.3
200	1.2	1.2	0.2	1.5	0.4	1.5	3.8	3.1	1.8	5.5	2.5	0.9	6.2	6	5.6	1.8	2	1.2
300	0.6	1	0.5	1	0.5	2.5	3.3	2.8	2.1	7.3	3.2	0.5	4.3	5.1	5.4	2.3	1.2	2.2
400	1.2	0.4	0.4	0.6	0.4	3.6	4.7	5.1	1.6	5.6	5.9	0.4	4.5	3.9	3.5	2.7	2.1	1.4
500	2.5	0.7	1	0.5	0.8	4.8	4	3.9	1.5	4	3.6	0.1	5.6	4.4	3.6	3.4	1.1	1.7
600	2.7	0.2	0.4	1.8	0.8	4.5	4.4	5.1	2.4	3.8	3.4	0.4	5.7	4.2	5.1	3.3	0.6	1.9
700	3.2	0.9	0.8	1.7	1	7.2	5.7	7	6.8	6.8	5.1	2.8	7.8	5.2	5.6	2.5	2.6	1.8
800	2.4	3.3	2.6	1.4	2.6	**8.3**	**8.1**	8.4	**8.7**	7.8	6.2	3.4	**8**	7.9	6.8	2	1.9	2.1
900	1.2	2.2	3.3	4.1	5	7.3	6.4	9.6	8.2	**9.9**	7.2	3.9	7.1	6.5	6	0.8	2.4	2.8
1000	2.6	2	4.5	4.3	3.9	6.4	6.3	8.9	7.2	8.6	6.6	2.9	6.6	7.5	6.1	1.4	3	5.7
1100	1.6	3.1	5.1	3.5	3.2	5	5.8	8.3	6.1	8.3	5.2	4.3	5.1	6.1	7.2	2.5	2.7	6.6
1200	2.7	3.4	4.8	4.8	1.8	4.4	2.1	7.4	5.2	6	5.2	3.6	6	7.2	7.7	2.7	3.2	7.8
1300	4.4	5.2	5	5	1.6	2.9	1.9	5.9	3.8	5.4	7.8	4.2	6.3	6.7	8	2.6	8.4	7.9
1400	4.7	4.7	8.3	6.8	1	2.3	2.1	7.6	1.1	4.9	**9.4**	6.5	5.7	8.4	9.6	2.5	4.7	8.7
1500	6.7	6	**10.6**	9	5.2	1.3	5.7	8.8	3.5	2.9	7.3	**9.3**	6.5	8.9	9.1	8.9	**10.2**	**9.7**
1600	**9.4**	**8.3**	8.9	**10.2**	5.9	1	4.4	3.5	1.9	2.5	6.6	7	7.1	9.1	**9.8**	**9.7**	5.1	8.3
1700	8.5	7.9	9.1	9.3	**8**	3.6	3.7	**12.4**	5.3	2.6	6.5	5	6.6	9.8	9.1	9.1	4.1	7.2
1800	6.7	7.3	7.9	7.7	7	4.2	2.9	7.7	0.9	2.6	6	4.4	3.7	**10.4**	9.2	7.9	4.1	6
1900	4.6	6.1	6.8	5.6	6	5.5	2.4	3	1.2	1	3.9	3.7	1.3	9.3	7.6	5.3	4.6	4.5
2000	4.2	5.4	6.5	5.5	4.7	3.7	1.7	3.8	3.6	2.4	3.2	4.7	5.1	8.3	7	3.3	4.1	3.3
2100	4.2	3.7	4.2	4.5	2.9	4.5	3.9	2.4	3.1	0.8	2.8	6.1	3.5	7.4	6.1	2.2	3.3	2.4
2200	2.9	3.2	2.6	3.4	3.3	3.3	4.8	1.4	3.3	3.4	1.2	4.9	2	5.7	4.8	2.4	1.2	1.6
2300	2.3	2.1	2.5	2.6	3.4	3.8	4.6	0.3	6.7	4.2	0.4	6	1.2	5.2	5.4	2.7	1.4	0.3

VI.3.2 Wind Speed Data (mph)—Aldine

TIME	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
0	0.6	4.3	2.6	3	2.5	2.3
100	0.7	3.6	2.3	2.3	1.8	2.9
200	1.3	4.1	2.1	2.4	2	1.6
300	1.1	5.9	2.7	2.5	2.6	1.5
400	1.3	5.8	3.8	2.2	2.2	2.5
500	1.7	5.5	2.3	2.3	4.9	2.6
600	1.5	4.5	3	3.1	5.5	3.8
700	1.4	3	3.2	5.2	7.4	5.3
800	1.4	1.5	4.1	7.2	7.5	5.8
900	2.4	4.1	2.9	**7.7**	7.6	6.1
1000	1	2.4	2.9	6.4	7.7	6.5
1100	1.8	2.4	1.7	5.2	**8.1**	**7**
1200	1.9	2.5	5.4	3.9	5.7	5.8
1300	7.4	2.4	5.6	5.6	5.7	5.8
1400	**9.7**	3.4	1.2	6.4	6.8	3.2
1500	8.5	5.1	5.3	5.4	7.3	3.2
1600	8.8	**5.9**	5.5	3.1	7.1	4.8
1700	8.1	5	**5.6**	4	6.8	3.9
1800	6.8	4	2.7	5.9	2.7	1.6
1900	6.2	3.8	2.9	7.4	1.2	0.8
2000	9.2	1.5	1.8	5.2	0.7	0.6
2100	3.3	1.2	2.7	6.2	0.8	1.7
2200	2.5	2.3	3.2	6.3	1.1	0.5
2300	1.6	2	2.7	4.4	1.4	0.4

VI.3.3 Wind Direction (0-359 degrees)—Aldine

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	181	169	172	278	226	116	275	95	141	202	239	213	245	219	204	162	130	67
100	177	109	172	261	263	197	344	**331**	137	208	238	226	232	223	175	284	111	28
200	153	192	326	277	266	104	55	12	28	219	250	223	255	222	233	268	74	51
300	145	108	32	2	270	63	**347**	45	37	241	265	218	236	238	204	**330**	64	41
400	108	109	133	279	289	87	328	48	89	197	266	199	210	23	223	34	64	79
500	88	106	84	107	259	56	250	22	105	23	268	315	16	42	266	41	58	33
600	101	154	**360**	36	255	17	251	53	99	2	273	**316**	232	16	10	27	11	**353**
700	167	153	81	75	286	81	342	87	118	**321**	274	273	**289**	136	**321**	24	38	14
800	170	166	116	299	296	31	328	96	161	271	**279**	237	283	**280**	293	14	23	2
900	206	173	137	231	282	69	14	102	144	276	269	236	255	279	290	19	35	344
1000	**211**	164	193	274	284	21	46	112	167	291	273	231	241	255	10	60	92	316
1100	163	178	213	273	226	40	56	129	149	301	258	231	243	236	182	184	103	336
1200	115	119	182	257	240	70	59	132	135	320	218	183	236	240	128	130	85	330
1300	127	210	155	291	278	113	79	132	138	294	119	206	213	198	105	103	94	127
1400	146	**313**	116	**321**	253	85	91	128	151	234	178	187	201	206	124	64	110	103
1500	136	20	124	68	230	100	102	140	144	243	137	143	168	195	129	112	109	106
1600	153	56	136	128	231	124	115	143	162	275	157	145	133	167	134	130	102	112
1700	141	308	130	158	113	125	119	136	159	259	136	142	142	141	137	101	99	107
1800	136	176	133	163	110	143	130	132	132	152	148	164	147	151	148	119	107	118
1900	129	143	132	176	130	143	129	130	143	155	162	166	175	171	155	129	126	109
2000	148	151	154	174	51	173	133	132	180	180	174	170	180	172	160	131	**151**	233
2100	157	161	176	198	**312**	183	135	69	181	206	187	173	182	175	154	123	135	109
2200	182	168	166	208	308	**245**	121	96	**194**	228	195	174	181	179	110	105	111	90
2300	174	176	184	215	128	198	155	119	180	231	198	189	169	181	172	68	134	146

VI.3.3 Wind Direction (0-359 degrees)—Aldine

	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
TIME																		
0	291	216	170	190	221	243	274	253	200	235	252	317	71	50	**93**	66	96	122
100	46	258	139	184	251	259	270	243	287	250	254	234	74	94	74	75	83	131
200	25	233	140	164	4	254	270	256	270	258	242	210	67	97	69	84	66	128
300	31	59	266	240	45	257	265	263	266	271	248	262	60	90	54	53	79	116
400	110	65	200	**246**	70	268	271	255	214	271	278	116	38	79	37	54	84	97
500	65	44	**277**	58	61	278	251	268	242	271	267	317	42	69	34	53	89	69
600	92	138	14	94	31	295	266	269	239	261	276	83	37	67	41	96	217	90
700	82	**305**	58	69	**345**	**296**	297	278	253	267	285	31	45	68	30	50	126	124
800	111	296	198	198	239	284	295	274	256	270	298	17	56	81	40	48	194	160
900	**349**	230	177	192	233	295	290	265	261	277	314	31	69	64	36	118	240	**318**
1000	67	143	196	194	227	293	297	252	277	269	337	**354**	76	48	36	38	**264**	60
1100	130	203	175	168	312	294	295	264	278	273	5	344	73	37	47	68	180	111
1200	92	201	168	179	237	263	**310**	279	261	288	22	4	93	59	54	128	187	116
1300	103	187	151	163	172	281	310	269	294	292	58	14	54	59	70	125	148	134
1400	134	177	132	128	211	195	304	246	229	258	76	18	63	49	74	**144**	176	138
1500	115	123	133	139	202	229	262	241	207	205	82	50	67	83	84	121	159	145
1600	114	137	144	145	156	138	201	**345**	178	237	101	81	71	91	80	137	145	151
1700	135	150	149	145	136	189	217	322	**358**	240	135	42	81	103	83	139	136	156
1800	138	156	160	159	165	166	222	258	5	255	145	43	111	**105**	83	133	143	164
1900	150	165	170	170	180	179	193	235	355	**309**	150	48	93	102	89	126	151	168
2000	176	174	170	174	172	194	160	81	302	148	166	42	123	94	84	109	138	155
2100	172	175	166	181	182	208	239	108	212	174	177	42	**142**	95	79	92	135	137
2200	164	185	170	180	211	223	252	253	232	235	194	44	102	92	59	101	144	136
2300	176	176	187	183	222	258	265	174	234	245	**347**	63	69	77	60	89	127	97

VI.3.3 Wind Direction (0-359 degrees)—Aldine

TIME	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
0	81	128	87	340	69	23
100	121	88	54	334	54	30
200	141	48	35	308	48	36
300	125	59	27	304	52	33
400	149	9	32	310	16	21
500	149	36	34	308	34	35
600	101	35	58	316	41	37
700	108	36	68	337	42	46
800	163	328	65	347	45	63
900	170	40	100	343	39	71
1000	263	358	165	340	43	83
1100	119	25	348	335	47	95
1200	86	139	255	357	54	44
1300	107	10	251	334	41	56
1400	104	62	39	323	38	51
1500	112	99	112	309	65	94
1600	112	102	114	226	68	97
1700	108	116	340	50	59	96
1800	120	96	333	34	35	139
1900	82	93	327	36	27	8
2000	56	34	5	48	348	50
2100	26	30	339	60	9	106
2200	356	107	329	62	9	208
2300	94	125	280	69	1	300

VI.3.4 Ozone (ppb)—Aldine

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	3	0	10	0	7	22	26	0	0	0	9	8	30	14	9	1	14	0
100	0	0	SPN	0	4	16	SPN	0	0	SPN	11	4	26	SPN	5	0	SPN	0
200	0	0	SPN	0	7	5	SPN	0	0	SPN	7	2	20	SPN	3	0	SPN	0
300	0	0	0	0	6	0	1	0	0	0	6	1	11	8	4	1	9	0
400	0	0	0	0	3	0	0	0	0	0	6	0	7	5	3	1	11	0
500	0	0	0	0	0	0	0	0	0	0	1	0	4	1	3	0	3	0
600	0	0	0	0	0	0	1	1	0	0	0	0	1	3	1	1	1	0
700	1	4	0	0	4	16	16	14	7	3	5	3	10	19	5	5	6	2
800	8	16	12	12	10	34	42	26	13	10	11	16	39	33	16	30	24	20
900	19	28	23	22	19	52	64	39	19	18	19	26	57	42	25	45	35	42
1000	31	38	35	27	29	96	77	38	26	27	32	37	68	48	39	67	35	53
1100	45	**45**	53	44	44	**127**	74	51	43	40	49	51	83	54	63	62	37	68
1200	70	31	59	62	69	110	75	52	**65**	54	69	83	92	64	96	48	36	83
1300	**83**	26	72	69	88	79	67	**55**	65	65	82	95	111	75	127	48	38	**89**
1400	76	14	**101**	86	98	74	70	44	48	68	111	103	108	77	**153**	58	54	60
1500	68	10	85	112	103	73	72	40	29	**70**	**150**	**111**	120	75	132	87	**66**	34
1600	61	3	67	**145**	**106**	75	76	34	26	64	126	101	**122**	**92**	127	**107**	53	22
1700	46	3	53	123	99	70	**94**	23	25	67	105	78	86	75	86	93	58	24
1800	33	7	23	77	90	66	92	13	9	36	68	57	58	38	48	61	51	13
1900	16	4	5	24	57	60	65	9	0	5	41	48	44	24	40	39	31	2
2000	10	2	0	13	53	39	49	9	7	1	26	35	44	17	22	23	15	0
2100	14	3	4	3	46	44	23	3	6	13	19	18	41	14	25	10	2	0
2200	4	7	0	8	37	30	10	0	2	11	19	18	29	13	12	7	0	0
2300	0	12	0	10	23	26	1	3	0	10	14	25	21	9	6	10	0	0

VI.3.4 Ozone (ppb)—Aldine

	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
TIME																		
0	0	0	0	4	4	8	20	36	0	15	AQI	8	53	6	26	7	8	0
100	0	0	SPN	3	2	SPN	22	30	0	SPN	AQI	3	49	28	23	7	SPN	0
200	0	0	SPN	0	2	SPN	16	28	0	SPN	AQI	3	42	29	22	6	SPN	0
300	0	0	0	0	0	0	9	24	0	8	AQI	2	38	22	19	4	0	0
400	0	0	0	0	0	0	3	23	0	8	AQI	0	SPN	18	11	2	0	0
500	0	0	0	0	0	0	0	11	0	4	AQI	0	SPN	5	5	1	0	0
600	0	0	0	0	0	0	0	6	1	4	AQI	0	22	3	4	2	0	0
700	3	1	9	0	0	4	4	15	14	9	AQI	0	33	16	9	4	7	3
800	18	20	25	8	12	12	17	26	29	15	AQI	14	44	36	17	9	26	11
900	31	24	30	18	20	19	27	39	41	22	AQI	46	53	45	25	20	30	11
1000	38	36	45	36	41	30	54	55	58	36	AQI	96	61	51	35	31	44	19
1100	57	44	55	52	59	44	79	74	76	52	AQI	109	69	58	39	48	56	41
1200	86	78	63	64	77	63	95	89	86	68	**91**	**112**	75	60	40	66	66	**45**
1300	131	102	70	66	91	80	105	94	94	**87**	87	110	**78**	**61**	41	72	**71**	45
1400	**166**	99	**80**	**78**	106	89	114	**97**	99	AQI	81	89	77	56	43	**93**	56	34
1500	140	**116**	61	75	102	97	121	90	100	AQI	79	81	77	52	52	80	63	39
1600	92	110	50	65	**121**	98	**133**	81	**101**	AQI	76	79	76	52	**54**	58	37	25
1700	59	83	32	44	89	**103**	131	69	83	AQI	77	77	78	48	37	43	24	18
1800	39	44	21	21	41	92	99	57	59	AQI	76	59	70	41	24	32	16	4
1900	11	22	17	11	22	51	53	43	35	AQI	54	44	41	37	16	18	9	3
2000	15	17	17	13	15	27	17	14	50	AQI	27	40	28	34	14	12	2	0
2100	15	16	10	11	6	22	21	29	29	AQI	41	56	31	32	13	5	1	0
2200	9	15	3	8	5	18	43	15	17	AQI	28	57	17	29	9	9	0	0
2300	3	8	2	7	11	17	36	2	24	AQI	19	56	3	25	7	6	0	0

VI.3.4 Ozone (ppb)—Aldine

TIME	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
0	0	7	0	0	41	8
100	0	SPN	0	0	27	SPN
200	0	SPN	0	1	27	SPN
300	0	5	0	0	32	24
400	0	7	0	0	23	31
500	0	2	0	0	22	29
600	0	2	0	0	21	28
700	0	2	0	3	33	37
800	6	1	9	12	43	46
900	16	4	23	22	51	54
1000	41	7	30	24	61	62
1100	70	11	37	33	68	65
1200	**100**	11	34	59	71	67
1300	89	7	31	81	**74**	68
1400	42	13	31	85	72	**71**
1500	49	**30**	44	87	71	71
1600	38	29	**45**	**94**	69	69
1700	29	20	29	77	63	61
1800	20	6	16	73	38	32
1900	18	2	3	63	15	3
2000	26	1	0	57	4	0
2100	20	0	0	55	0	0
2200	13	2	0	53	0	0
2300	8	3	0	49	0	0

VI.4 TNRCC DATA--CONROE

VI.4.1 Temperature Data (°F)--Conroe

VI.4.2 Wind Speed Data (mph)--Conroe

VI.4.3 Wind Direction (0-359 degrees)--Conroe

VI.4.4 Ozone (ppb)—Conroe

VI.4.5 Particulate Matter ($\mu g/m^3$)—Conroe

VI.4.1 Temperature Data (°F)—Conroe

TIME	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
0	79.5	79.1	76.8	74.1	81.2	75.4	78.7	72.7	78.3	75.5	81.1	80.6	77.5	77.1	79	78.4	76.6	74.3
100	78.1	77.2	75.1	73.5	79.3	74.4	76.8	71.8	77.4	74.9	79.4	78.5	75.9	75.7	77	77.3	75.1	73.9
200	76.2	75.5	73.9	73.2	78.1	73.6	75.9	71.1	75.7	72.6	78	75.6	75.7	74.5	75.6	75.6	74.7	73.4
300	74.3	74.4	72.6	71.8	76.6	72.4	75.9	70.9	74.8	71.7	77	73.4	75.3	73.9	74.3	73.9	73.8	72.8
400	73.8	74.3	72.1	70.9	76.4	71.5	73.8	70.6	74.4	72	76	72.3	73.7	73.9	73.4	73.1	73.5	72.5
500	72.5	74.1	71.3	69.8	76.8	70.5	73.5	70.2	74.5	71.1	75.4	70.7	72.7	71.8	73.2	72.7	73.5	72
600	73	75.8	72.4	70.5	77.3	71.1	73.9	72	75.3	71.8	75.9	71	72.7	70.3	72.6	73.5	73	72.8
700	78	80.2	77.3	76.4	79.7	75.7	78.1	78.3	79.7	77.9	78.8	77.5	77.1	76.2	76.7	77.8	74.6	76.3
800	83.1	83.8	82.7	81.7	83.4	80.6	82.7	84.4	84.6	82.4	83.1	81.3	82.1	81.4	82.6	82.8	78.6	80.6
900	86.4	86.7	85.5	85.8	87.8	85.8	87.4	86.9	86.9	85.1	86.9	84.6	85.4	84.9	85.6	84.9	82.6	84.3
1000	89.2	88.3	88	88.7	92.3	89.2	91.5	90.2	88.3	88.2	90.5	88.3	88.8	88	89.3	86.7	86	86.9
1100	90.8	91.5	90.9	91.7	95.8	92.5	94.2	91.2	90.8	91	93.5	91.7	91.8	90.3	92.1	**89.2**	**87.9**	88.2
1200	92.5	**92.4**	92.6	94	97.5	94.5	95.7	92.8	92.2	93.5	96.3	94	94.6	93	94.6	80.6	83.3	91
1300	94	86.6	94.5	96.2	98.9	96.7	96.2	94.4	94.3	95.5	97.1	96.2	96.3	95	96.5	71.8	79.5	92.3
1400	94.8	77.4	95.7	97.5	99.6	98.1	96.6	**95.3**	94.6	96.8	97.6	98	97.6	97	97.2	74.2	84.1	**93.2**
1500	**95.5**	77.7	**96.7**	98.3	**100.2**	**99.5**	96.9	94.5	**94.9**	97.9	97.6	98.5	**98.7**	**97.9**	**98.9**	78.3	85.3	84.5
1600	95.2	80	96.6	**98.5**	99.9	98.8	**96.9**	93.4	93.6	**98.4**	**98.7**	**98.6**	98.5	97.7	98.4	82.1	85.2	85
1700	93.5	81.8	94.9	97.7	99	98.9	96.1	91.1	91	98.2	97.5	97.6	97.9	97.2	95.8	83.2	84.9	83
1800	90.4	82.2	91.8	96	82.5	97	92.7	89.1	86.7	96.5	95.2	93.8	94.5	95.3	93.7	82.5	84.2	81.1
1900	87	80.3	87.8	92.5	80.9	91.8	88.5	86.5	83.5	92.6	92	90	89.3	90.6	90.1	79.8	82.5	78.7
2000	84.5	79	84.6	88.8	77.5	89.7	85.1	84.4	81.9	88.1	88.6	86.8	86.1	87.6	87.5	78.2	80	77.5
2100	82.9	79	82.2	86.1	79.3	87.7	81.1	82.7	80.8	85.2	86.2	84.2	82.9	85.3	84.3	79.3	77.6	76.4
2200	81.4	78.8	80	84.5	78.3	84.1	77.9	81	80.2	83.7	83.9	81.8	80.9	82.8	81.7	77.5	76.1	74.6
2300	80.5	77.8	77.1	83.1	76.3	81.1	74.9	78.6	78.8	83	82.3	79.3	79.1	80.9	79.9	76.6	74.8	73.8

VI.4.1 Temperature Data (°F)—Conroe

	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
TIME																		
0	73	77.5	77	78.1	78.7	81.2	84	86.2	81.2	83.1	83.4	81.5	83.7	77.4	74	75.3	76	78.8
100	71.7	76.1	74.2	76.4	77.6	79.6	81.9	84.7	80.5	81.8	84.8	79.6	81	75.3	74	74.7	75.9	78.1
200	71.6	75.1	72.2	73.9	76	78.3	81	81.7	80.1	80.6	82.1	78.2	78.4	76.5	73	74.1	74.8	77.2
300	71.2	73	71.3	73.1	73.3	77.1	79.2	79.8	80.5	78.9	78.7	77.1	75.7	75.2	72.5	74.3	74.4	77
400	70.5	71.3	70.3	71.7	71.7	75.9	76.7	77.8	79.5	77.8	78	76.2	72.7	73.4	71.9	74.4	73.9	75.5
500	70.4	70.7	69.5	70.8	71	75.6	75.4	79.4	78.7	77.2	76.9	75.5	69.8	72	72.1	74.3	73.7	74.4
600	70.8	71.1	70.5	71.1	71.2	76.4	76.5	79.4	78.3	77.7	76.9	75.5	69.4	71.9	72.2	74.3	74.1	74.4
700	73.9	76.1	76.3	77.2	77.8	79	82.2	83.8	80.1	82.5	82.2	82.4	72.7	75.4	73	74.7	76.7	75.7
800	79.4	80.8	82.4	83.2	82.3	82.1	87.9	88.4	82.6	87.7	91.4	90.9	76.3	78.7	74	75.7	81.7	80
900	84.1	83.8	85.3	86.1	85.4	85.3	93.2	92.3	84.8	91.4	97.1	96.5	79.7	81.3	76	77.9	84.7	84.5
1000	85.9	87.3	88.6	89.1	88.8	89.3	97.6	96.9	90.1	95.5	101.4	100.4	83	85	78.1	81.4	85.9	88
1100	88.3	90.2	91.2	91.4	91.7	93.3	100.4	100.6	96.2	98.9	104.2	102	86.7	87.9	80.6	84.8	88.5	**89.5**
1200	90.6	92.2	93.7	93.6	94.3	96.8	102.3	103.1	99.4	101.7	106.1	**103.5**	90.1	89.5	82.5	87.1	91.3	86
1300	92.8	94.5	95.1	94.9	96.5	99.3	103.3	104.3	101.5	102.3	107	103.5	92	91	85.4	**89.2**	93.3	83.8
1400	94.5	95.4	96.2	96.7	98.1	101.3	103.7	103.9	102.7	103.4	106.8	103.3	92.7	**92**	**86.4**	89.1	**94.8**	83.1
1500	94.5	96.3	**96.9**	**97.2**	100	102.5	104	**104.5**	103.3	104.7	**107.5**	102.6	93	92	85.7	88.9	92.9	86.6
1600	**94.8**	**96.3**	96.2	96.7	**100.2**	**103**	**104.5**	91.1	**103.5**	**105**	107.3	102.2	**93.5**	91.5	86	89	91.7	88
1700	93.8	95.2	93.2	95.3	99.1	102.4	104.2	88.7	101.8	103.7	106.4	101.3	93.1	89.2	84.6	87.4	88.4	88.8
1800	91.2	92	90	91.9	95.7	98.8	100.5	88.2	96.4	99.7	103.2	98.6	91.5	86.2	82.6	84.7	85.8	86.5
1900	87.8	88.4	87.1	88.2	91.5	92.8	93.7	86.1	91.9	95.7	96.7	94.5	88.2	82.8	79.5	82.4	84.2	84.3
2000	84.8	85.6	85	85.7	88.7	91.7	92.5	83.6	89	93	93.6	90.7	86	79.9	77.9	80.6	83.3	82.5
2100	82.7	83.2	83	83.4	86.1	90.1	91.6	82	88.2	89.9	89.7	88.7	84.7	77	76.5	79	82.2	80.9
2200	81	81	80.9	81.3	84.1	87.5	89.6	80.7	86.8	86.5	87	86.8	82.1	75.3	75.9	78.2	80.9	78.9
2300	79.5	79.2	79.3	79.8	82.9	86.1	88.1	80.4	84.7	83.3	83.6	85.5	79.7	74.1	75.9	77.2	79.7	77.4

VI.4.1 Temperature Data (°F)—Conroe

	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
TIME						
0	76.8	74.7	75.7	74	71.6	65.6
100	75.9	74	75.1	73.5	70.4	64.7
200	75.3	73.8	74.3	73	68.4	63.6
300	75.2	74	74	72.8	67.6	63
400	75.2	74.1	73.7	72	65.8	61.7
500	74.9	74.3	73.6	72	64.4	60.8
600	75.1	74	73.5	72.3	64.6	60.8
700	76.5	74.5	76.1	74.2	68	65.7
800	79.6	74.8	79.5	76.3	71.6	70.3
900	83.7	75	82.1	79.5	74.9	74
1000	87.1	75.9	84	83.8	77.7	77.8
1100	89.7	79.3	84.8	88.1	80.7	80.1
1200	91.6	**81**	85.5	90.6	82.5	82.2
1300	**92.8**	79.2	**87.1**	92.1	83.2	84
1400	91.1	76.6	86.9	**92.9**	84.2	84.9
1500	89.9	76.6	77.1	92.9	**84.8**	85.3
1600	90.6	77.5	74.1	89.8	84.8	**85.4**
1700	85.9	78	74.8	86.7	83.7	84.4
1800	76.2	77.5	74.2	83.7	79.7	80
1900	75	76.9	73.7	81	75.3	71.8
2000	75	76.5	73.8	78.8	71.5	66.8
2100	75.5	76.4	73.9	76.7	68.5	66
2200	75.9	76	74.1	74.8	68.3	64
2300	74.9	75.9	74.1	73	67.4	61

VI.4.2 Wind Speed Data (mph)—Conroe

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	3.1	1.3	1.6	0.6	5.6	0.5	1	0.7	1.1	1	4.4	2.5	2.1	1.4	1.4	0.5	0.7	0.8
100	2.1	0.7	0.6	1.4	5.8	0.8	0.9	0.5	0.9	0.3	5	1.3	3.1	1.5	0.1	0.2	0.7	0.6
200	0.5	0.8	1.1	0.8	4.5	0.5	1.3	1.1	0.7	0.6	4	0.2	3.8	1.5	0.3	1	1.8	0.3
300	0.8	1.5	0.4	0.7	4.6	0.8	1.1	1	1.1	0.8	2.9	0.6	4.1	2.3	0.4	0.7	1.9	0.7
400	0.7	0.5	0.6	0.4	4.5	0.7	0.9	1.4	1.1	0.8	2.8	0.8	2.1	2.5	0.8	0.8	1.9	0.9
500	1	0.5	0.8	0.5	4.4	0.4	1.5	1	1	0.7	3.8	0.4	0.5	0.8	1	1	1.6	0.6
600	1	0.9	1.5	0.6	2.3	0.7	2	1.7	1.5	0.5	4.2	0.4	0.9	0.6	0.9	1.3	1.7	0.9
700	0.9	1.8	1.8	0.2	4.5	1.3	3.2	2.2	1.3	2.4	6.2	3.4	5	1.9	0.8	2.3	1.9	1.7
800	5.1	5.1	2.6	3.8	**6.6**	1.7	3.1	2.9	3.5	**6.7**	5.6	7.3	**6.8**	**7.3**	5.9	1.2	2.3	1.7
900	5.8	5	5	4.1	5	2.3	3.5	3.5	5.6	4.7	4.4	4.4	5.1	7	3.9	1.8	2.7	1.5
1000	5	4.9	4.1	2.5	0.9	1.1	3.7	3.7	4.8	4.6	4.2	3.2	3.9	6.7	1.9	0.8	2	1.4
1100	4.9	4.1	4.8	2.2	3	2	4.4	3.5	4.9	4	2.2	2.4	2.6	3.8	2.2	2.5	2.9	2
1200	4	3.7	4.5	2.3	2.8	2.5	**6.9**	4.1	3.3	5.5	2.1	3.5	3.5	4	2.6	**5.2**	**4.1**	1.1
1300	4.6	**5.7**	4.6	1.8	0.7	**4.4**	6.6	4.9	3.8	3	3	4.3	3	3.5	4	2.7	2.9	1.1
1400	4.8	2.1	4.5	2.2	2.7	2.6	6.4	5.1	7.1	5.2	3.1	4.4	3.4	6.4	4	2.1	2.5	3.5
1500	5.4	0.6	4.9	3.6	1.8	3.7	5.1	**8.6**	**8.9**	3.9	4.7	3.9	4.5	5.8	5.4	1.6	2.7	**7.1**
1600	**8.2**	1.8	4.1	2.2	2.3	3.7	3.8	7.8	8.7	5	3.8	4.3	2.9	7.2	5.7	2.2	2.6	5.2
1700	7.7	0.9	4.5	**5.7**	3.6	2.6	4.8	8.2	4.1	3.5	4.2	5.1	3.7	6.9	6.1	1.4	2.9	4
1800	7.9	3	**7.7**	4.3	3.3	1.7	3.8	6.9	3.4	2.4	**6.2**	**7.5**	4.8	5.5	4.3	1.5	1.9	4.2
1900	5.2	1.5	6	2.3	4.8	0.9	2.3	3.8	0.7	1.3	4.3	4.1	5.2	4.5	**7.2**	0.8	1.8	2.9
2000	4.1	1.9	5.4	3.9	2.9	1.7	1.4	2.7	0.7	0.2	6	4.1	5.9	5.8	3.6	1.3	1.2	2.3
2100	3.4	3.4	4.2	5	5.9	1.9	0.8	1.8	0.1	0.8	5.6	5	4.4	5.2	1.1	1.6	0.5	1
2200	3	4.9	2.6	3.6	0.9	0.4	0.6	1.2	1.2	3.2	3.8	3.3	4	4.2	1	1.1	0.5	0.5
2300	2.5	2.6	0.2	3.9	0.4	0.5	0.8	1	0.9	4.7	3.4	2	2.7	2.6	0.7	1.3	0.6	0.3

VI.4.2 Wind Speed Data (mph)—Conroe

TIME	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
0	0.6	0.5	1.1	2	2.4	5.6	4	3.1	2.8	2.6	1.1	0.4	6.4	0.8	3.7	3.7	1.4	2.3
100	1	0.9	0.6	0.7	2.1	4.8	2.7	1.7	2.1	3.7	3.4	0.5	5	0.7	3.9	3.4	1.2	1.8
200	1.2	1	0.6	0.5	0.6	4	2.5	0.2	1.8	4.8	1	0.6	5	3.3	3.4	2.1	1.2	1.5
300	0.8	0.5	0.7	0.5	0.6	4.1	0.9	0.3	3.4	4	0.9	0.5	3.5	3.2	3	1	1.4	1.4
400	0.8	0.6	0.6	0.6	0.7	4.9	0.5	0.9	2.6	2.7	0.9	0.4	1.8	2.3	3.3	1.8	1.9	0.9
500	1.1	0.7	0.7	0.7	0.6	4.4	0.8	1.8	1.3	2.5	0.8	0.5	1.6	3.2	3	2.4	1.4	1
600	1.3	0.6	0.4	0.7	0.5	3.5	1.1	2	1.3	2.6	1.4	0.7	2.3	2.8	2.9	2.3	1.3	1.2
700	1.3	0.9	0.3	0.5	2.7	5.2	4.1	4.4	3.6	4.7	3.3	2.9	4.3	3.3	3.5	1.7	1.5	1.1
800	1	5.6	5	4.9	**7.1**	6.8	**6.4**	7.1	**5.5**	7	3.9	2.5	**6.9**	4.4	4.8	0.9	2.8	1.4
900	0.4	3.2	4.8	5.1	5.7	5.8	5.9	7.6	5.2	**8.5**	3.8	2	5.7	4.1	4.6	1.8	2.9	3.5
1000	1.8	0.8	5	4.8	4.1	**7**	3.8	7.1	5.2	7	3.3	2.5	5.1	6.2	5.3	2.6	3.6	4.9
1100	1	2	5	4.6	2.8	4.8	2.3	5.8	3.8	2.8	3.6	3.2	4.5	6.7	5.4	2.4	1.6	3.9
1200	2.7	1.5	5.6	3.7	0.5	4.8	2.1	5.3	4.1	4.3	5.2	2.3	5.4	8.1	6.4	1.8	3.1	3.9
1300	3.4	3.3	4.2	3.2	3	4.7	2.7	3.7	1.2	2	8.2	6.3	4.8	**9.7**	4.5	3.4	3.1	5.5
1400	3.5	3.3	3.7	3.4	1.7	2.9	2.9	4	3.8	0.3	**8.2**	**8.7**	6.3	8.5	6.5	3.5	3.6	4.9
1500	3.4	4	3.5	3.8	1.8	3.8	5.8	4.2	0.1	3.3	6.8	7.2	5	8.5	**7.8**	3.9	7.6	3.1
1600	4.3	4.7	**7.8**	3.8	3.6	2	5	**10.6**	2.3	3.4	6.1	7.7	5.2	7.8	7.3	5.2	**8**	3.9
1700	4.9	4.4	7.8	6.3	6.4	1.3	4.5	6.3	2.3	1	5.8	5.5	5.6	7.9	5.7	**6.5**	6.9	**6.4**
1800	5.2	**5.7**	5.7	**6.4**	5.3	0.7	1.5	5.1	3.7	2.2	2.7	3.6	3.4	7.6	6.3	4.3	3.3	4.4
1900	**5.5**	3.9	4.5	4.1	6.6	0.9	0.8	2.1	0.6	1.1	0.6	2.7	2.4	5.9	4.8	4	2.1	2.7
2000	4.8	4.4	3.5	3.4	4.1	1.8	0.4	1.6	1.4	2	0.7	2.8	3.2	4.1	3.7	2.6	2.6	2.8
2100	3	4	3.1	4.5	2.8	3.5	2.4	0.7	4.1	1.1	0.3	2.9	3.6	3.6	4.1	2.1	3.7	2
2200	2.5	4	3.2	3.8	3	3.5	2.1	0.5	2.4	0.5	0.6	2.9	2.1	3.5	4.3	1.5	4.8	1.1
2300	2.2	2.3	3.6	3.4	3.8	5.3	3.8	3.3	1.8	0.7	0.5	5.5	1.5	4.1	3.9	1.2	3	1.1

VI.4.2 Wind Speed Data (mph)—Conroe

TIME	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
0	0.1	2.5	1.9	0.7	2.8	2.5
100	0.9	3.4	1.9	1.1	2.4	2.9
200	1.1	4.3	1.8	0.9	3.3	2.5
300	1	4.6	1.7	0.5	3.6	2.6
400	0.8	4.3	2.2	0.5	3	3.1
500	1.3	5	0.9	0.5	3.4	3.1
600	1.2	4.3	1.3	1	3.9	2.8
700	1.5	**5.3**	2	1.9	6.3	4
800	2	4.4	1.9	2	**7.5**	**6**
900	1.5	2.3	1.2	2.2	7.1	5.6
1000	1.1	2.4	1.6	2.1	6.7	4.2
1100	1.7	2.1	1.5	1.5	5.9	3.8
1200	2.4	1.4	1.5	3.8	6.7	3.5
1300	2.8	4.4	1.2	3.4	7.2	3.8
1400	4.9	1.5	3.7	3	6.6	3.8
1500	4.5	0.6	2.3	3.9	6.6	4.8
1600	3.3	1.5	2.7	**6.7**	5.7	4.5
1700	5.9	1.7	4.8	6.4	3.9	3.4
1800	**11.2**	1.4	**5**	4.7	1.9	1.2
1900	6.9	2.5	1.8	3.1	1.5	0.7
2000	2.6	2.4	0.6	3.1	1.1	0.7
2100	0.6	1.4	1.5	3	1.4	0.8
2200	0.8	0.9	1.1	3.1	2	0.7
2300	1.5	1.2	1.2	2.9	2.9	0.7

VI.4.3 Wind Direction (0-359 degrees)—Conroe

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	198	140	179	315	237	33	317	320	110	323	236	204	240	204	182	58	141	49
100	177	91	**356**	271	239	61	28	22	81	280	231	210	267	218	245	317	48	40
200	116	**346**	348	284	254	41	9	352	41	5	231	304	240	228	282	347	22	31
300	48	26	23	318	265	8	319	**355**	13	283	233	42	256	228	1	311	19	15
400	13	42	338	320	265	327	49	6	50	270	262	338	273	238	317	338	45	**341**
500	**345**	51	338	**358**	263	**351**	351	16	23	**344**	261	345	276	**293**	323	**358**	43	6
600	65	59	23	20	**276**	58	21	41	40	40	260	**358**	**302**	24	**340**	12	24	327
700	124	117	64	227	273	100	49	65	100	257	257	244	259	246	279	19	70	72
800	180	168	149	227	258	139	65	105	158	247	263	249	240	246	258	338	74	112
900	186	179	182	228	263	141	62	131	181	246	**273**	225	224	233	258	101	76	154
1000	181	192	149	207	245	89	72	114	187	216	251	205	228	224	206	71	150	247
1100	177	162	168	220	39	99	63	107	189	222	192	162	183	220	126	183	195	271
1200	160	124	157	239	79	87	43	104	172	225	126	193	181	170	155	156	111	43
1300	179	114	184	106	97	88	47	131	160	218	217	190	198	153	129	347	17	32
1400	170	104	158	141	75	68	60	130	161	220	182	165	169	184	91	35	98	101
1500	173	113	157	160	66	66	57	151	175	233	154	171	149	193	154	73	125	120
1600	161	130	158	165	228	82	75	145	167	223	153	156	134	191	141	124	121	119
1700	153	139	138	199	163	77	78	144	202	258	158	145	135	176	141	96	141	139
1800	151	208	162	174	160	109	114	149	278	276	152	152	143	165	137	105	142	156
1900	147	147	154	195	91	69	115	143	**297**	258	148	145	156	139	154	93	153	152
2000	144	157	155	174	250	141	105	133	280	156	156	148	167	160	139	73	207	176
2100	150	154	163	186	251	148	85	136	37	118	173	167	176	165	79	120	77	148
2200	157	174	180	219	266	319	1	93	239	228	187	178	189	165	69	85	11	28
2300	174	175	168	236	101	10	**358**	100	268	233	195	190	196	181	11	108	**354**	58

VI.4.3 Wind Direction (0-359 degrees)—Conroe

	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
TIME																		
0	41	201	147	195	225	235	265	263	157	238	251	**356**	63	**350**	85	75	79	145
100	**347**	269	349	210	235	236	267	222	200	243	257	338	65	10	81	71	77	166
200	34	285	345	30	226	235	273	165	238	256	289	349	**72**	75	66	60	11	145
300	345	**343**	305	**353**	356	260	274	47	265	266	290	343	57	78	59	**333**	25	144
400	56	26	4	351	**359**	266	**299**	285	269	263	258	331	27	58	54	48	22	77
500	54	286	341	327	325	266	271	260	223	269	269	350	5	54	45	64	61	40
600	62	21	**353**	32	269	**270**	226	266	226	259	278	36	30	32	46	64	50	87
700	89	239	204	146	239	268	266	272	222	257	251	37	48	59	39	120	100	95
800	160	244	226	205	243	260	276	272	241	266	286	41	61	76	43	181	164	139
900	105	235	204	212	229	262	270	265	249	266	307	353	69	78	46	158	151	**211**
1000	88	219	197	203	238	251	273	261	237	259	**342**	316	66	63	46	174	**215**	191
1100	135	183	196	177	235	250	281	254	242	243	43	42	71	46	56	135	198	161
1200	140	153	161	188	155	235	270	247	267	237	46	17	64	56	57	141	171	83
1300	147	167	192	190	79	211	213	230	**342**	218	59	52	64	61	69	162	175	78
1400	153	148	158	172	193	187	176	294	228	169	57	58	62	56	80	139	174	82
1500	127	142	127	127	136	203	236	297	125	227	58	48	49	60	80	115	144	92
1600	133	140	161	123	154	194	247	73	302	227	50	56	57	59	80	130	147	138
1700	146	136	150	149	177	213	253	161	334	**335**	57	51	63	75	82	141	151	152
1800	151	149	141	147	154	25	285	216	245	283	85	47	56	82	86	136	141	141
1900	160	145	139	141	160	108	32	189	335	43	116	43	36	88	**91**	129	130	132
2000	164	147	143	140	173	203	190	**359**	223	43	90	45	50	92	85	123	126	134
2100	155	150	144	159	172	220	237	29	222	243	42	44	68	93	70	111	144	124
2200	152	174	152	159	193	241	262	257	243	14	332	37	56	89	73	118	153	111
2300	159	188	183	196	215	244	261	153	239	309	315	57	37	79	79	100	155	113

VI.4.3 Wind Direction (0-359 degrees)—Conroe

TIME	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
0	184	43	47	299	41	37
100	85	47	14	282	35	43
200	113	59	356	309	36	41
300	113	57	9	314	45	35
400	126	60	37	354	35	39
500	103	63	21	7	41	43
600	49	58	19	341	55	39
700	89	58	67	360	58	53
800	71	60	83	10	63	70
900	127	55	74	320	65	70
1000	198	71	52	353	61	74
1100	103	61	13	26	62	73
1200	114	89	321	45	53	67
1300	89	172	157	360	57	41
1400	120	122	31	22	50	45
1500	112	268	56	31	52	59
1600	97	69	246	54	53	55
1700	61	73	256	52	39	46
1800	61	28	261	52	8	353
1900	54	28	293	54	6	326
2000	30	50	250	57	25	343
2100	191	75	285	63	12	360
2200	222	36	301	44	24	329
2300	58	35	317	35	43	319

VI.4.4 Ozone (ppb)—Conroe

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	6	9	1	0	15	17	16	36	9	0	12	14	15	26	11	27	12	8
100	4	5	SPAN	0	14	14	SPN	29	7	SPN	11	9	15	SPN	6	22	SPN	6
200	1	3	SPAN	0	11	12	SPN	26	3	SPN	8	5	21	SPN	2	17	SPN	4
300	0	2	0	0	9	5	15	24	1	0	6	2	27	18	2	12	9	2
400	0	1	0	0	10	1	15	22	0	0	3	0	18	23	1	5	10	1
500	0	0	0	0	9	0	10	14	0	0	1	0	13	12	0	4	10	1
600	0	4	0	0	9	2	19	23	2	0	3	0	9	3	1	4	7	2
700	2	10	5	7	15	20	36	37	8	7	8	7	29	18	5	17	13	15
800	12	20	17	20	21	33	52	38	25	21	15	23	54	34	24	35	25	32
900	19	29	25	29	30	59	69	34	31	23	25	37	60	37	30	48	38	45
1000	29	34	34	37	42	78	70	32	41	25	40	52	65	39	39	57	40	54
1100	45	47	49	44	54	80	69	33	55	CAL	53	67	69	42	53	**65**	44	61
1200	68	**60**	70	53	63	**84**	60	37	69	CAL	60	74	71	43	62	61	43	**68**
1300	95	56	77	59	64	75	58	39	71	CAL	67	86	76	47	63	47	41	66
1400	**105**	41	76	61	63	66	59	40	81	39	71	99	82	55	65	40	45	61
1500	100	34	87	61	65	64	62	43	**87**	**42**	72	116	93	63	64	41	**51**	64
1600	91	30	93	61	66	66	65	**44**	79	41	76	128	106	72	66	49	48	55
1700	79	29	**112**	80	**68**	64	68	40	48	40	85	**130**	114	75	70	46	48	54
1800	56	23	96	94	63	60	72	31	28	37	**119**	117	**124**	**89**	**80**	41	43	50
1900	35	12	45	**111**	59	53	74	22	21	27	76	74	94	79	59	21	33	39
2000	29	5	26	84	49	44	**75**	18	13	17	51	49	57	37	39	12	18	32
2100	21	6	12	36	47	46	65	13	4	13	35	39	44	24	32	30	14	22
2200	12	6	6	18	38	35	49	10	0	9	26	33	37	19	32	23	10	12
2300	14	3	2	15	28	24	39	9	1	15	18	24	34	15	30	16	8	6

VI.4.4 Ozone (ppb)—Conroe

TIME	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
0	1	5	11	7	7	14	25	33	43	35	25	18	50	32	25	12	17	7
100	0	3	SPN	2	6	SPN	22	27	38	SPN	21	11	SPN	27	25	11	SPN	3
200	2	2	SPN	0	4	SPN	22	23	26	SPN	14	10	SPN	33	23	9	SPN	2
300	0	1	0	0	0	7	21	19	26	9	9	5	45	30	22	8	4	3
400	0	0	0	0	0	5	12	10	22	8	8	5	40	25	21	8	3	0
500	1	0	0	0	0	6	2	7	19	8	4	0	26	20	20	6	2	0
600	2	0	0	0	0	8	0	11	12	7	4	4	33	18	19	6	4	1
700	7	6	6	4	3	10	13	27	13	13	14	19	38	24	19	7	9	3
800	20	18	26	18	22	16	34	44	23	20	33	52	42	34	20	10	24	10
900	28	29	32	26	29	23	47	52	30	30	50	67	48	40	24	16	35	22
1000	40	39	36	39	38	37	58	60	50	47	70	77	53	45	29	29	41	33
1100	46	47	44	52	47	47	70	68	68	60	**76**	**85**	58	48	34	40	46	43
1200	50	54	50	65	54	53	81	73	73	74	73	81	62	**50**	38	46	52	48
1300	57	63	63	79	59	59	83	76	81	78	67	81	64	50	**40**	50	58	52
1400	66	75	64	83	67	65	83	76	84	80	67	74	65	50	38	49	64	**54**
1500	66	87	67	89	72	71	**86**	**77**	**85**	79	66	72	**66**	48	37	60	79	53
1600	73	126	84	107	81	72	86	75	81	**83**	67	74	65	46	40	**92**	**83**	46
1700	**82**	**140**	**87**	**112**	99	**75**	82	73	76	76	67	71	65	43	36	55	56	48
1800	76	121	53	87	**134**	67	66	69	73	65	60	68	61	40	33	38	46	38
1900	62	88	30	44	129	45	41	61	56	62	48	67	52	41	25	34	34	20
2000	43	46	20	23	75	45	48	49	42	61	47	63	52	37	22	31	24	12
2100	22	22	12	13	39	42	43	47	50	47	41	61	50	31	19	27	17	5
2200	10	19	8	11	20	28	33	42	46	38	37	58	45	29	17	27	12	5
2300	8	16	8	10	12	27	33	37	42	29	24	55	37	27	14	22	11	3

VI.4.4 Ozone (ppb)—Conroe

TIME	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
0	0	15	2	3	36	37
100	0	SPN	1	3	34	SPN
200	0	SPN	0	1	31	SPN
300	0	12	0	1	35	38
400	0	12	2	1	34	38
500	0	11	1	4	32	39
600	0	10	0	5	33	36
700	4	11	6	8	38	41
800	12	12	15	9	43	46
900	25	12	20	16	49	51
1000	36	13	24	29	55	55
1100	47	22	24	49	58	57
1200	**55**	**26**	27	61	59	59
1300	54	24	**29**	63	59	**62**
1400	39	18	28	68	60	62
1500	38	10	24	74	62	62
1600	38	17	20	**80**	**63**	62
1700	36	15	7	80	61	61
1800	37	7	8	68	44	45
1900	37	5	9	59	33	35
2000	28	5	6	54	33	25
2100	25	3	2	47	31	23
2200	21	1	2	44	33	34
2300	13	0	2	40	35	23

VI.4.5 Particulate Matter ($\mu g/m^3$)—Conroe

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	11.29	7.34	5.69	14	8.74	13.32	15.2	21.72	12.29	7.75	19.89	18.04	28.23	18.87	5.7	11.71	13.35	9.48
100	6.88	4.75	3.06	13.5	7.63	13.71	16.41	21.65	10.29	8.02	20.85	17.74	25.36	22.53	6.7	13.38	13.66	9.9
200	2.75	5.76	1.53	14.07	7.83	12.92	16.41	22.07	9.51	6.14	20.21	15.02	26.47	18.51	5.91	10.67	14.55	10.41
300	2.45	6.4	0.14	11.68	6.75	12.82	17.42	23.25	8.62	6.62	19.04	12.9	20.47	24.32	5.64	11.61	14.02	8.8
400	4.28	7.15	1.28	9.44	6.66	11.82	16.51	23.6	9.18	6.93	18.51	12.66	17.92	16.36	6.51	12.83	15.92	9.81
500	3.15	8.09	2.73	9.2	6.67	11.84	15.93	25.49	9.54	5.49	19.64	11.92	18.88	14.83	7.5	14.11	13.81	10.77
600	22.54	**21.34**	18.91	13.67	8.03	15.74	16.55	28.85	12.38	10.6	21.16	17.15	24.6	20.42	10.86	19.57	17.11	**20.35**
700	25.24	14.61	**24.04**	17.02	7.53	16.31	15.61	**30.35**	12.7	19	22.23	27.54	27.19	27.86	20.87	**25.68**	23.18	19
800	4.03	6.7	12.68	9.39	6.06	17.11	20.27	10.41	3.29	13.16	20.12	18.34	14.53	14.67	11.24	21.64	**24.85**	14.23
900	7.62	3.33	5.17	6.13	11.75	**17.55**	20.72	4.87	4.98	13.44	20.84	15.27	22.08	8.72	5.87	16.27	15.49	7.87
1000	14.13	9.12	6.09	7.99	15.69	12.01	8.24	2.1	7.45	13.37	16.06	14.84	16.97	6.19	5.55	18.75	6.97	6.33
1100	**31.09**	7.25	7.71	6.88	14.77	8.28	7.72	0.14	10.72	13.51	15.08	15.89	14.16	4.72	6.36	19.04	7.1	7
1200	24.04	9.29	17.98	7.14	17.11	12.49	4.39	2.58	11.97	10.77	15.73	15.82	10.4	6.06	9.59	8.45	10.39	6.3
1300	23.57	9.63	17.14	7.27	17.27	12.72	5.48	2.65	12.15	12.15	16.03	16.37	15.79	5.91	14.91	12.3	3.47	6.03
1400	21.97	15.07	17.67	8.94	15.27	9.75	3.48	3.43	17.23	10.95	15.85	18.22	14.88	4.38	12.9	12.08	6.32	14.66
1500	18.93	8.22	18.4	7.52	15.3	7.54	6.3	3.72	22.07	11.85	17.71	23.84	15.16	7.97	14.15	16.8	12.27	10.8
1600	13	8.38	19.54	9.65	14.6	9.78	6.78	4.33	**22.11**	11.62	15.66	23.15	22.25	12.51	16.94	14.25	12.24	2.14
1700	13.61	7.83	23.86	11.04	17.79	11.2	7.59	3.12	16.06	9.29	19.07	24.29	21.05	15.58	11.62	5.95	5.62	2.89
1800	5.98	1.8	21.63	15.13	**21.74**	13.95	19.95	7.57	10.55	9.46	21.66	28.71	**38.25**	26.34	**30.51**	14.65	9.06	4.97
1900	17	9.41	17.78	22.32	15.02	12.5	16.13	13.71	10.96	10.92	19.63	28.97	33.84	**32.27**	18.57	11.42	7.05	4.01
2000	16.46	6.58	18.41	**27.65**	13.27	17.5	19.36	17.09	12.11	14.64	**28.89**	28.98	26.42	15.04	8.11	14.29	9.1	3.63
2100	11.14	7.11	17.75	20.9	9.14	16.21	20.23	14.58	11.39	21.43	21.05	26.99	25.52	7.2	10.33	16	9.56	5.24
2200	10.98	2.08	16.55	13.68	13.04	14.2	**23.02**	12.91	11.94	**23.68**	20.38	**29.74**	23.67	5.94	9.57	14.86	8.99	3.12
2300	12.78	5.39	15.77	11.52	12.85	15.14	21.09	12.26	9.97	19.05	19.25	29.16	21.73	6.54	11.85	17.99	9.42	3.57

VI.4.5 Particulate Matter ($\mu g/m^3$)—Conroe

	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
TIME																		
0	3.75	3.86	3.31	5.96	6.9	3.79	0.49	17.33	21.2	16.03	LIM	LIM	10.15	26.42	7.78	2.79	7.63	10.64
100	2.45	4.27	4.48	3.44	6.22	3.12	3.07	16.28	19.52	16.86	LIM	LIM	9.38	28.37	8.03	3.17	8.71	11.84
200	6.43	2.82	2.77	2.71	2.54	2.41	0.76	15.66	18.98	8.68	LIM	LIM	10.64	**30.63**	8.98	1.43	8.21	11.88
300	3.76	1.88	3.78	3.72	-0.12	0.66	2.79	14.82	17.46	6.77	LIM	LIM	12.74	30.41	8.08	0.4	8.01	11.64
400	5.38	1.62	4.32	1.03	1.6	1.1	3.38	15.86	15.13	4.63	LIM	LIM	12.83	25.75	8.34	1.3	8.79	11.27
500	3.63	3.32	3.7	2.9	1.7	2.14	5.86	12.86	13.12	4.02	LIM	LIM	15.12	24.27	9.11	1.16	8.55	12.21
600	8.11	10.71	13.38	11.8	12.16	5.99	11.31	17.84	15.27	5.66	LIM	LIM	20.51	18.62	9.46	2.26	12.73	14.1
700	**14.8**	16.13	**21.59**	21.71	26.12	1.92	5.3	15.71	22.4	3.93	LIM	LIM	24.09	18.06	10.02	3.69	15.47	**17.18**
800	7.91	6.06	7.43	6.01	7.76	0.8	5.69	12.1	9.47	3.1	4.07	LIM	25.8	11.49	12.85	5.72	9.54	15.29
900	1.15	2.62	4.95	6.46	2.62	1.91	3.79	15.37	11.18	9.7	11.02	LIM	**27.76**	28.45	13.87	5.95	6.26	4.58
1000	1.84	2.42	1.3	3.45	2.52	1.16	11.5	10.93	9.65	10.38	12.42	11.55	26.44	9.94	13.61	4.55	3.41	2.82
1100	1.64	1.26	2.64	10.75	5.91	1.67	7.29	9.29	3.85	9.66	6.62	LIM	24.85	3.22	**14.44**	3.35	4.04	7.6
1200	1.72	1.89	3.14	5.52	1.7	1.09	8.01	7.37	8.53	7.07	12.21	AQI	22.71	2.21	13.51	2.6	3.71	13.93
1300	1.91	2.71	9.55	8.11	3.7	1.31	9.74	10.68	6.54	10.5	12.77	AQI	25.22	1.38	8.93	3.66	4.68	6.45
1400	4.92	2.85	8.46	9.85	2.32	4.3	10.99	15.05	9.39	9.21	11.13	19.03	26.38	1.23	5.49	6.5	5.76	5.76
1500	3.93	10.62	4.52	14.34	6.08	3.69	10.23	9.56	12.95	10.62	13.32	18.85	25.49	2.6	8.32	8.01	15.44	4.66
1600	3.83	20.63	17.62	**24.35**	7.63	4.42	8.71	**30.39**	10.48	14.3	13.04	19.95	24.85	0.95	4.73	**19.96**	12.63	2.57
1700	5.34	**23.37**	18.39	22.29	8.92	6.38	11.52	6.83	13.67	10.04	13.87	16.09	23.36	3.15	7	6.41	6.74	3.39
1800	2.61	18.2	8.1	12.09	**33.82**	4.67	13.84	21.73	**22.63**	19.86	17.71	15.85	23.38	3.69	7.35	9.13	2.76	6.09
1900	8.98	20.09	8.01	9.1	33.14	10.51	15.26	16.93	17.48	17.3	**19.1**	19.58	24.63	16.54	0.66	10.27	11.78	7.28
2000	9.23	9.28	4.78	12.73	25.86	15.88	16.02	15.55	18.51	18.86	LIM	20.63	25.75	15.69	2.6	8.57	**17**	6.64
2100	11.41	8.58	2.94	13.41	19	**26.92**	17.91	18.26	14.68	25.3	LIM	26.98	23.22	10.16	3.12	9.54	14.61	6.38
2200	8.81	7.51	4.77	13.46	9.43	18.09	17.05	18.2	13.07	**38.37**	LIM	**33.74**	23.68	6.51	3.53	8.14	11.83	3.73
2300	6.72	6.45	5.91	11.24	3.19	7.82	**21.04**	22.43	13.64	LIM	LIM	20.91	25.86	6.1	2.96	7.84	10.5	3.66

VI.4.5 Particulate Matter ($\mu g/m^3$)—Conroe

	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
TIME						
0	2.14	0.89	6.27	5.24	**14.78**	9.62
100	2.89	1.71	3.17	4.54	13.23	7.99
200	4.74	2.4	3.26	2.69	10.15	8.14
300	4.34	3.08	4.89	2.34	6.57	7.3
400	4.32	4.08	4.36	1.08	7.21	8.66
500	6.22	4.48	4.24	2.51	6.62	7.58
600	7.6	4.54	7.43	4.79	8.04	11.15
700	**12.47**	4.6	**10.27**	5.82	8.03	12.51
800	11.2	5.45	8.71	6.5	5.87	8.19
900	7.95	6.71	8.14	4.76	7.56	8.89
1000	5.21	**9.22**	4.12	3.12	6.12	5.96
1100	9.92	4.74	5.62	5.71	2.31	3.61
1200	12.24	3.99	3.69	10.08	5.2	3.81
1300	8.71	7.11	2.76	5.69	3.66	3.95
1400	7.69	3.66	3.59	10.11	2.13	4.95
1500	4.69	8.27	5.66	13	2.7	3.83
1600	1.87	4.55	3.91	15.23	6.54	5.36
1700	2.75	5.42	5.12	18.3	6.39	3.5
1800	-0.05	2.42	5.17	16.89	7.71	4.93
1900	2.94	3.49	4.2	19.79	11.43	5.03
2000	3.62	3.07	5.17	**20.36**	8.68	11.87
2100	2.34	3.29	5.09	19.31	11.33	**17.1**
2200	2.06	5.28	4.11	17.91	10.18	12.16
2300	1.77	5.98	5.5	16.35	9.25	11.12

VI.5 TNRCC DATA--GALVESTON

VI.5.1 Temperature Data (°F)--Galveston

VI.5.2 Wind Speed Data (mph)--Galveston

VI.5.3 Wind Direction (0-359 degrees)--Galveston

VI.5.4 Ozone (ppb)—Galveston

VI.5.5 Particulate Matter ($\mu g/m^3$)—Galveston

VI.5.1 Temperature Data (°F)—Galveston

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	83.3	84	83.6	83.6	82	83.4	83.3	84.1	83.9	83.1	82.2	83.3	83.6	83	83.8	84.3	84.5	84
100	83.1	83.8	83.6	83.1	81.2	83	82.6	83.8	83.7	83	81.9	83.3	83.3	82.7	83.5	84.2	84.1	83.8
200	82.8	83.6	83.7	82.4	81.2	81.9	81.6	83.8	83.7	82.8	80.9	82.8	83	82.7	83.2	84.1	83.9	83.7
300	82.7	83.6	83.6	82.2	80.2	81.9	81	83.8	83.3	82.5	79.8	82.3	82.7	82.8	82.8	84	83.8	81.8
400	82.3	83.3	83.3	82	79.4	81.4	80.7	83.4	83.5	81.4	79.5	82.2	82.5	82.9	82.6	83.7	83.5	80.7
500	82.3	83.4	83.4	81.2	79	81.1	80.9	83.7	83.6	80.4	79.5	81.9	80.9	82.8	81.9	83.7	81.7	82.1
600	83	83.8	83.6	81.2	79.4	81	81.7	84.2	83.9	80.7	79.4	81.9	80.6	83.2	81.6	84	78.4	81.4
700	84	85	84.6	82.3	79.8	82	83.4	85	84.9	82.6	79.9	83.1	81.8	83.8	82.5	84.8	81.2	82.1
800	84.8	85.5	85.1	83.9	80.8	82.8	85.2	85.7	86	83.8	81.2	84.9	84.3	83.5	83.6	83.9	83.8	83.2
900	85.4	85.5	85.7	84.9	82.9	84.5	86.6	86.5	86.5	85.4	83.5	86	85.6	85.3	85.2	85.4	84.2	84.9
1000	85.9	86.1	86	85.4	85.7	85.5	87.9	86.9	87	86.9	86	87	85.8	86.2	86.1	86.5	82.6	82.5
1100	85.9	85.9	86.5	85.7	86.8	87	88.5	87.5	87.4	**88.1**	**89**	86.3	86.4	86.8	86.6	86.2	80.6	82
1200	86.6	86.2	86.7	86	**89.5**	87.9	**89.8**	87.7	87.4	87	88.5	86.8	86.7	86.8	**87.5**	85.5	81.5	**85.5**
1300	**87**	86	86.9	86.1	87.9	89	88.9	87.9	87.6	87	88.1	86.6	86.7	87.1	87.2	86.4	82.9	84.9
1400	86.9	86.1	86.8	86.4	87	**89.5**	88.8	**87.9**	**87.9**	87	88	87	**86.9**	**87.2**	86.7	**86.6**	84	81.5
1500	86.7	**86.4**	**87.1**	86.7	87	88.6	89.4	87.7	87.3	87.1	87.6	**87**	86.9	87	86.7	86	84.8	81.6
1600	86.5	85.7	86.6	**86.9**	86.8	87.7	88.7	87.2	86.7	86.8	87.4	86.6	86.6	86.7	86.5	85.9	**85**	81.5
1700	85.9	85.1	86	86.1	87	87.1	87.6	86.5	85.7	86.4	87	86.2	85.7	86.1	86	85.7	84.4	81.9
1800	85.2	84.1	85.3	85	85.8	86.5	86.9	85.7	83.8	85.3	86	85.6	84.7	85.3	85.4	85	83.5	81.8
1900	84.6	83.3	84.5	83.9	84.9	85.5	85.8	84.2	83.4	84.7	85.4	84.8	84.2	84.9	85	84.8	83.7	81.7
2000	84.6	83.5	84.2	83.5	85.3	85	85.4	83.9	83.9	84.5	85.3	84.5	84.2	84.8	84.9	84.5	83.8	81.9
2100	84.4	83.6	84.2	83.1	85	84.4	84.9	84.1	84	84.1	84.9	84.3	83.8	84.5	84.7	84.7	84.1	81.9
2200	84.2	83.6	84.1	83	84.2	84.2	84.3	84.2	83.5	83.6	84.5	83.9	83.5	84.2	84.5	84.5	84.1	82
2300	84.2	83.5	83.9	82.7	84.1	83.6	84.2	84	83.2	82.7	83.9	83.9	83.3	83.9	84.6	84.2	83.9	82

VI.5.1 Temperature Data (°F)—Galveston

	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
TIME																		
0	81.6	82.9	83.8	84.3	84	83.7	83	84.2	85.7	83.3	83.3	84.5	**88.1**	81.7	77.4	79.9	83.5	83.8
100	81.6	82.5	83.8	84.1	83.8	82.3	82.1	83.3	85.1	82.8	83	84.1	86	**82.6**	75.5	81.8	83.5	83.5
200	81.8	82.2	83.6	83.9	83.7	81.6	81.4	82	84	82.8	82.7	84.1	83.4	82.1	75.2	81.8	83.2	83.2
300	81.3	82.2	83.4	83.8	83.4	80.8	80.4	82.5	83.4	82.2	81.8	83.5	79.6	81.6	74	81.4	82	83
400	80.6	81.6	82.9	83.3	83	80.3	80.1	83.3	83.1	81.7	81	83.4	78	80.8	73.9	78.2	83	83.2
500	80.6	80.8	82.8	83.3	82.8	79.9	79.8	82.4	83	80.9	79.8	83.8	76.3	80.1	74	78.6	82.3	83.2
600	79.8	81.1	83.1	83.9	82.6	79.5	79.3	82	83.2	80.8	79.9	84.6	75.1	78.1	74.2	79	81.9	83.6
700	82	82.3	84.7	85.3	84.4	80.5	80.3	81.8	84.2	81.4	81	86.9	75.4	79.2	75.6	80.2	83.1	83.8
800	82.5	83.8	85.6	84.2	85.2	82.3	83.2	84	85	83.6	83.9	89.6	76.8	79.3	75.6	81.1	84.6	83.8
900	83	84.9	86	86.4	85.5	84.6	86.6	87	87.3	86.9	88.3	89.4	79.1	80.1	76.4	80	85.6	84.8
1000	85.2	85.8	86.4	86.8	87.3	87.8	91	89.5	89.9	90.1	92.4	92	81	80.9	78.1	77.5	85.8	86.3
1100	85.5	86.2	86.9	87	87.3	90.5	94.8	**90.1**	**91.1**	**93.1**	95.6	94.3	83.3	81.3	79.2	79.1	86.2	86.4
1200	85.4	86.2	**87.3**	87.1	87.5	**92**	**96.8**	88.6	89.4	92	**97.8**	96.6	84.1	81	78.9	82.2	86.2	**86.7**
1300	85.8	86.3	87.1	**87.4**	87.8	90.5	93.5	88.8	88.8	90.2	92.8	99.2	84.4	81	78.2	82.8	86.4	86.2
1400	86.2	**86.8**	87.2	87.3	**87.8**	89.2	91.6	89.2	88.8	89.6	91.6	**100.6**	84.9	81.7	77.6	83.2	**86.8**	85.7
1500	**86.2**	86.6	87.2	87.2	87.5	88.8	91.7	88.5	89.1	89.6	91.3	98.7	85	81.2	77.8	82.3	86.3	85.8
1600	86	86.4	86.8	86.8	87.7	88.7	90.9	88.8	88.4	89.4	89.5	91.6	84.8	81.3	79.2	83.3	86	85.1
1700	85.5	86	86.3	86.2	87	87.6	89.4	88.4	87.4	88.4	88.5	92.5	84.6	81.2	79.1	82.4	85.5	84.8
1800	84.5	85	85.3	85.3	85.9	86.3	88	87.5	86.3	87.9	87.2	92.1	84.4	80.1	78.8	82.3	84.7	83.9
1900	83.9	84.4	84.7	84.7	85.2	85.6	87.6	87.9	86	87.6	87.2	89.5	84.4	79.3	79.5	82.5	84.3	83.6
2000	83.9	84.4	84.4	84.5	84.9	85.2	87.5	87.9	85.8	85.6	86.9	87.4	84.4	78.9	80.5	82.7	84	83.7
2100	83.5	84.2	84.4	84.4	84.5	85	87.5	86.2	85.3	84.8	86.1	87.2	84.4	78.7	**81.7**	83.3	84.1	83.7
2200	83.5	84.1	84.2	84.3	84.4	84.2	85.9	85.4	85	84.3	85.5	88.4	84.1	78.2	81.6	**83.6**	84	83.3
2300	83.3	83.9	84.2	FEW	84.1	84.1	84.7	85.5	84	83.9	85.1	89.7	82	77.9	79.9	83.4	83.8	83.2

VI.5.1 Temperature Data (°F)—Galveston

	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
TIME						
0	83.2	78.4	82.1	79.6	80.6	78.7
100	83.1	80.5	82.4	79.3	80	77.3
200	82.9	81.2	82.5	79.5	78.8	73.9
300	82.6	82	81.9	77.9	77.5	71.3
400	82.7	81.6	79.9	77.5	75.9	70.6
500	82.7	81.1	76.8	77.2	74.5	70.2
600	82.9	78.5	76	77.5	72	69.4
700	84.3	80.5	75.6	79.4	71.5	70.9
800	85.1	FEW	76.1	80.6	72.6	73.1
900	86	82.6	78.2	81.3	74	75.4
1000	86.5	83.7	80	82.3	76.8	77.6
1100	86.5	**84.6**	81.3	83.8	79.2	79.1
1200	87.1	83.4	82.7	85.2	81.3	79.9
1300	**87.1**	77.4	83.9	86	82.3	**80.7**
1400	87	74.5	83.8	87.6	83.5	80.4
1500	85.9	75.5	83.8	88.3	84	80.6
1600	85.3	78.3	**84.3**	88.8	**84.4**	80.3
1700	85.4	77.9	83.4	**88.9**	83.9	79.8
1800	84.6	78.3	83.1	87.3	82.5	79.1
1900	84.6	78.4	82.5	86.8	81.5	78.8
2000	84.6	79.9	81.8	84.4	80.7	78.4
2100	84.2	81.5	81.3	82.7	80.3	78
2200	79.8	82.1	81.3	81.5	79.5	77
2300	78.8	82.2	80.9	80.2	79.1	76.5

VI.5.2 Wind Speed Data (mph)—Galveston

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	11.4	11.9	**15**	**11.5**	8	2.8	6.1	10.6	14.2	10.5	7.1	10.2	8.5	12.7	**12.4**	8.3	9.8	7.6
100	11.1	12.2	13.5	10.2	8.5	1.7	3	9.4	**15.9**	9.7	7.4	10.2	9.6	13.4	12.2	8.3	**10.5**	7.5
200	9	10.5	12.3	8.8	8.2	2.8	3.4	9.3	15.8	9.9	7.9	9	9.9	13.7	11.9	7.6	9.6	6.1
300	5.8	11.4	11.5	7	8.9	2.6	5.2	8.6	13.4	7.9	6.7	6.2	9.1	**13.7**	10.7	8.2	8.9	8.7
400	4.8	10.5	8.6	6.1	2.8	3.8	6.9	9.8	14.8	6.1	7.8	5.8	7	12.2	9.2	6.8	5.4	2.3
500	5.6	10.3	8.6	2.4	5.3	4.4	8.3	9.9	12.8	5.2	7.1	4.8	3.2	10.2	5.5	4	6.9	3.4
600	5.9	9.7	8.4	1.5	9.2	3.8	10.1	9.8	11.2	4.1	6.9	4.6	2.8	8.2	2.8	3.1	6.6	4.7
700	6.8	11.7	8.6	4.2	10.5	6	6.9	11	11.1	6.1	8.3	4	2.8	6.6	4.5	4.7	2.3	5.7
800	7.8	11.6	8.4	2	6.7	7.8	6.7	11.5	9.9	7.6	9.2	6.1	2.2	5.2	4.9	5.4	4.9	4.7
900	8.7	11	7.3	6.1	5.1	5	6.8	12	10.3	8.2	9.4	6.2	6.7	6.3	2.6	5	5.3	3
1000	8.9	14.2	8.3	7.2	7.3	5.5	8.6	13	10.1	6.5	5.9	8.4	7.7	8.3	4.5	8.5	5.7	5.4
1100	10.5	17	9.6	7.9	6.8	8.3	8.7	12.8	10.6	8.1	2.6	10.2	8.1	11.1	9.2	9	6.1	4.5
1200	9.6	14.2	9.3	8.2	7.4	5.9	6	13.5	11.1	13.5	8.6	9	9.3	11.4	11.3	10	2.8	5.7
1300	10.4	**17.2**	10	8.1	13.1	3.8	11.2	14.3	12.9	13.4	8.2	9.6	9	11	10.1	9.2	4.9	10.4
1400	11.1	15.2	10.5	9.4	15.4	6.7	12.2	**15.8**	13.6	12.2	10.4	10	9.9	10.8	8.2	9	7.8	**12.9**
1500	12.2	15.2	10.9	9.3	16.6	8.3	**12.4**	14.9	12.7	**15.5**	11	**10.3**	9.9	11.2	9.1	9.5	9.6	11.4
1600	10.7	13.4	10.6	10.3	**17.9**	9.1	12.2	14.8	8.7	14.7	11.9	10	10.2	11.8	8.9	**10.5**	9.8	8.8
1700	10.9	11.2	9.9	11.2	16	10.2	10.8	14.4	11	14.5	12.5	9.3	11.1	13.1	8.7	9.2	9.1	8.3
1800	11.9	11	10	10.5	6.6	9.7	9.2	13.8	13.8	14.2	**12.8**	8.6	9.9	12.4	7.8	8.3	9.6	6.1
1900	11.8	8	10.1	10.3	2	9.4	10.1	12.8	11.2	12.7	12.2	7.7	10.7	11.4	7.4	8.9	9.8	5
2000	**12.6**	10.5	9.6	10.4	2	**10.7**	10.8	5.2	10	12.3	11.5	8.2	11.6	11.5	8.8	9.9	9.2	4.1
2100	11.7	11.3	11.6	9.4	1	10.4	12.3	6	11	11.8	11.8	7.6	12.2	12.1	8.8	9.2	9.5	6.1
2200	11	13.5	11.3	11.3	1	9.4	11.7	11.2	11	9.8	12.6	7.1	**12.4**	12.3	8.4	8.7	8	7.3
2300	10.7	15.5	11.7	10.5	1.3	7.9	12.3	11.4	11	7.4	11.6	7.7	11.5	12.5	8.1	9.3	7.5	7.8

VI.5.2 Wind Speed Data (mph)—Galveston

	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
TIME																		
0	7.5	7.6	11.2	**13.8**	12.7	7.6	11	9.1	11.9	10.2	10.6	4.1	15.3	11.9	10.7	11.5	11.6	11
100	5.1	7.4	11.8	13.4	12.2	6.1	11.1	9.6	13.5	9.6	9.6	4.6	**16.1**	15.3	10.5	11.8	12.1	10.8
200	5.1	5.8	11.8	11.5	11.6	7.2	10.9	5.9	10.6	10.7	11.4	6	12.7	13.6	10.6	11.3	**13.4**	10
300	4	4.5	10.2	11.3	10.4	8.6	9.9	5.1	9.7	11.6	11.8	6.1	11	12.3	12.7	8	11.1	8.6
400	1.4	2.9	7.4	8	8.5	7.7	10.4	8.2	8.9	11.5	**12.8**	6	12.1	10.8	12	5.7	10.4	8.8
500	2.1	2.8	7.3	4.8	6.7	8.1	10.7	7.7	8.6	11.2	11	7	13.4	9.3	11.3	3.4	8.9	7.7
600	1.1	3.3	6.4	4.1	4.2	8.8	10.6	9.7	7	12.7	11.5	5	13.7	8	10.4	2.9	7.7	8.8
700	3	3.2	6.2	8.8	3.4	10.8	13.8	10.3	12.9	13.1	10.5	5.5	13.1	11	11.6	3.3	5.6	7.2
800	5.9	3.1	5.1	7.9	3.8	11.3	14.5	11.3	14	14.7	9.9	9.5	13	12.5	13	5.2	6.7	7.1
900	5.3	1.1	5.2	5	5	10.6	11.4	11.6	11.1	14.1	9	9.5	11.8	12.1	**13.7**	6.7	7.2	8.9
1000	7.5	6.7	6.5	5.9	5.2	8.2	9.1	12.9	9.6	12.4	6.4	9.3	13.7	10	13	2.6	9.8	10.7
1100	9.9	8.2	10.1	7.5	9.8	4.8	7.1	14.1	9.3	10.5	3.8	9.6	13.1	13	12.8	8.1	12.5	12.4
1200	9.9	8.6	11.4	9.1	9.8	1.7	4.3	19.9	14.3	14.7	4.9	9.7	12.7	10.2	11.9	9.3	12	**12.6**
1300	10.2	9.7	11.2	9.2	10.3	8.7	11.6	20.9	17.1	17.4	8	9.8	11.9	13.1	13.3	11.5	13	11.6
1400	**11.3**	9.4	11.4	11	10.5	9.5	14.6	22.5	20	19.4	11	9.4	12.8	12.3	11.6	14.1	12.8	11.2
1500	10.7	9.8	12.2	11.2	11.4	9.7	14.9	**23.4**	19.6	19.6	9.5	5.9	11.4	16.3	11.2	**15.6**	12	11.9
1600	9.9	10.3	**13.1**	12.1	12.3	11.5	16.2	21.6	**20**	**20.7**	10.8	9.2	8.3	15.6	12.6	13.2	12.8	10.8
1700	9	10.8	12.3	11.9	**12.8**	**13.7**	15.8	19.3	19.2	20.2	12.6	0.8	6.2	15.8	10.5	14.5	12.3	10.5
1800	7.9	10.9	11.6	11.1	12	12.8	**16.6**	14.8	18.9	16.4	10.2	1.1	6	**17.5**	9.6	11.5	11.9	9.5
1900	7.1	10.3	11.2	10.6	11	12.2	15.4	13.3	17.8	9	8.3	4.3	4.9	16	5.1	12.4	12	9.2
2000	7.8	10.3	10.9	10.6	10.1	11.7	13	7.6	17.6	10.7	6	2.5	5	13.3	10.6	11.6	11.5	8.6
2100	7.7	10.2	12.1	10.3	9.7	11.7	12.3	11.3	15	6.1	5.1	3.4	6.2	12.4	10	11.7	12.3	7.5
2200	6.8	**11**	12.2	10.7	9.3	9.6	10.2	8.1	13.8	8	4.8	4.7	5.3	12.2	10.9	13	11.1	7.2
2300	6.3	11	12.4	FEW	8.6	9	6.1	8.1	11.8	10.2	3.8	**13**	6.7	10.9	12.1	13.2	11.2	7.3

VI.5.2 Wind Speed Data (mph)—Galveston

TIME	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
0	5.9	9.1	7.7	4.5	**14.5**	10.9
100	5.5	8.6	**8.1**	4.7	13.1	12.1
200	6.1	17.8	5.5	5	13.5	9.7
300	6.6	15.6	1.4	5.5	13	9.3
400	8.2	15.8	3.3	5.8	11.6	10.3
500	6.2	14.2	3.2	5.1	10.2	10.3
600	3.8	**19.7**	5.9	3.9	11.4	11.7
700	3.9	15.1	5.6	7	14.1	12.5
800	3	FEW	3.5	11.8	13.1	13.5
900	5.1	6.8	4.1	12.2	13	**13.9**
1000	8.2	6.7	3.8	11.8	12.9	13.8
1100	11.6	6.2	4.2	11.5	13.1	12.9
1200	9.5	10.4	2.9	10.1	11.6	9.8
1300	10.9	7.5	3.8	9.2	11.8	7.8
1400	10.2	4.8	4.7	8.1	12.2	7.4
1500	11.9	12.6	6.5	6.4	13.1	5.6
1600	9.8	7	7.4	5.4	11.8	6.8
1700	11.1	6	6	4.3	12.5	4.4
1800	10.8	1.8	3.4	1.5	10.2	3.6
1900	10.8	7	4.5	4.8	9.8	3.3
2000	**12.5**	7.5	3.5	12.9	10.8	3.5
2100	12.5	9.6	4	13	11.8	2.7
2200	8	9.5	3.6	**14.5**	10.7	2.1
2300	9.8	8.3	4	12.9	10.3	2.8

VI.5.3 Wind Direction (0-359 degrees)—Galveston

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	176	144	156	174	234	88	201	134	160	189	242	174	186	184	176	151	144	134
100	177	156	159	186	241	175	257	130	164	199	254	177	193	192	184	151	155	151
200	182	154	161	197	255	258	285	129	170	209	265	185	195	196	190	170	157	137
300	**186**	151	155	201	273	257	312	119	172	215	253	190	198	209	200	179	161	126
400	170	153	153	204	293	258	308	112	171	230	265	203	209	205	206	183	167	119
500	158	151	180	242	288	282	310	131	165	253	259	214	266	208	228	159	224	213
600	143	157	**187**	304	287	329	306	127	157	280	**286**	227	317	219	262	90	270	259
700	126	151	160	**352**	290	316	330	125	154	275	284	**245**	**326**	244	303	88	359	289
800	123	147	147	24	255	297	**342**	126	141	**281**	280	211	227	**284**	292	**222**	**360**	279
900	127	157	143	134	239	314	9	126	139	265	280	190	173	257	**308**	141	62	247
1000	119	151	132	151	260	1	24	130	138	276	274	177	157	190	98	99	43	**349**
1100	118	160	132	149	261	4	15	126	136	200	219	179	152	177	104	89	79	23
1200	123	161	125	161	262	**351**	22	118	142	183	174	173	156	169	102	80	349	117
1300	120	158	126	140	185	134	96	114	149	183	160	173	155	157	101	94	20	101
1400	126	160	129	142	189	133	96	119	154	176	157	166	152	162	120	88	70	86
1500	130	**173**	128	155	196	142	104	126	165	182	156	160	147	162	124	98	80	93
1600	131	167	128	160	205	159	104	126	140	182	154	162	149	170	131	98	89	86
1700	128	155	129	175	206	168	103	123	152	190	155	165	157	175	131	107	100	116
1800	125	160	131	186	194	178	102	134	**182**	198	160	169	161	178	138	116	106	135
1900	137	145	135	183	237	186	104	147	180	199	164	169	171	178	138	115	107	141
2000	137	144	143	192	36	190	107	130	164	206	172	173	174	180	144	110	115	135
2100	143	143	146	199	127	202	129	114	165	215	173	164	173	174	143	110	117	141
2200	141	149	148	204	273	208	144	142	177	227	174	157	178	175	145	132	120	148
2300	137	159	156	208	**343**	195	143	**150**	179	241	175	170	178	179	145	147	128	168

VI.5.3 Wind Direction (0-359 degrees)—Galveston

	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
TIME																		
0	188	192	164	168	181	222	262	257	235	257	241	260	70	**106**	44	144	172	172
100	190	197	166	173	187	246	267	261	244	250	255	267	67	83	36	156	177	185
200	196	209	168	179	192	252	270	259	254	257	260	277	53	78	33	180	178	**187**
300	198	204	181	184	202	268	267	229	250	255	265	284	34	79	23	185	186	187
400	**318**	247	184	196	200	263	263	234	234	268	279	290	30	73	27	271	172	170
500	317	274	193	204	204	277	277	252	245	273	288	301	27	65	32	309	179	162
600	15	333	**199**	205	239	287	286	265	249	273	283	319	29	33	29	312	208	183
700	11	335	190	191	224	290	284	**271**	260	**276**	289	343	37	38	17	329	203	182
800	4	**356**	172	**259**	280	295	290	266	261	276	**295**	**360**	43	42	24	**349**	**221**	163
900	30	62	153	202	**294**	299	**296**	250	272	272	288	19	54	43	24	290	178	155
1000	93	133	141	171	188	292	287	246	**279**	267	288	19	61	28	25	27	159	152
1100	102	127	152	162	175	**315**	274	216	211	254	21	11	62	3	29	89	161	153
1200	104	128	160	153	175	58	238	198	196	209	15	15	77	82	29	103	173	151
1300	106	129	160	143	148	136	193	207	194	206	171	10	81	90	38	114	164	158
1400	115	138	157	153	147	151	203	212	198	210	188	12	95	81	45	111	168	160
1500	136	145	153	151	156	163	208	211	203	210	189	52	112	82	25	123	165	153
1600	146	151	158	160	168	184	212	216	205	213	180	59	124	80	32	129	161	153
1700	148	154	159	163	168	195	215	219	208	215	195	28	**129**	75	27	130	167	158
1800	155	154	164	159	182	202	222	230	216	221	203	242	126	80	25	139	162	155
1900	158	159	162	158	192	208	227	243	219	237	214	270	118	71	48	144	160	152
2000	173	167	155	160	192	215	235	238	225	232	224	268	100	64	105	145	153	158
2100	166	163	152	162	197	226	247	233	238	234	240	311	90	61	126	138	158	165
2200	165	166	155	168	206	244	248	234	245	246	248	25	68	56	**138**	145	160	148
2300	170	171	164	FEW	211	255	239	236	254	246	262	71	108	54	126	159	159	150

VI.5.3 Wind Direction (0-359 degrees)—Galveston

	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
TIME						
0	151	45	155	307	54	51
100	152	69	161	317	52	49
200	152	90	166	335	54	41
300	160	101	73	295	49	39
400	158	127	21	316	46	50
500	165	161	351	313	41	47
600	**166**	190	19	316	34	49
700	147	188	**354**	346	30	55
800	124	FEW	39	5	33	55
900	108	130	40	2	31	57
1000	104	148	34	**360**	37	68
1100	104	125	28	4	31	67
1200	101	83	17	7	25	52
1300	99	30	137	3	31	52
1400	112	**331**	114	358	18	**359**
1500	120	89	103	10	25	78
1600	105	110	88	22	41	99
1700	104	94	24	10	51	108
1800	97	41	23	88	**57**	112
1900	94	57	341	37	56	122
2000	93	77	33	38	56	102
2100	83	94	23	40	56	61
2200	88	116	10	41	54	31
2300	43	137	329	46	54	32

VI.5.4 Ozone (ppb)—Galveston

TIME	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
0	14	23	23	29	21	27	64	**48**	22	24	12	43	68	41	31	48	40	**51**
100	15	21	SPN	28	20	27	SPN	33	25	SPN	11	45	66	SPN	33	51	SPN	45
200	15	21	SPN	28	19	23	SPN	26	**32**	SPN	6	41	65	SPN	34	53	SPN	45
300	14	23	21	26	16	24	35	22	27	14	8	40	64	37	33	61	33	45
400	12	23	20	26	14	23	48	22	19	11	9	42	64	36	34	65	30	43
500	15	24	21	20	13	19	41	24	18	10	8	37	57	36	32	63	32	30
600	19	26	20	18	15	13	35	23	17	7	5	34	38	35	29	57	34	31
700	21	23	21	18	14	22	37	22	16	12	12	37	33	34	20	65	31	34
800	22	25	22	27	15	28	57	23	15	16	13	43	64	34	31	65	33	39
900	24	26	23	30	22	39	69	24	15	20	20	44	**69**	40	36	70	36	37
1000	27	**29**	25	30	35	73	113	25	14	38	30	47	69	**42**	40	**72**	37	37
1100	31	27	25	30	45	93	**136**	25	16	**39**	38	44	68	38	52	72	41	41
1200	31	27	22	32	46	122	130	26	16	27	45	44	65	35	57	70	40	44
1300	33	27	23	**36**	49	132	135	26	15	25	50	41	63	36	**60**	67	46	43
1400	38	27	24	35	**76**	139	127	23	16	22	59	43	61	29	53	68	45	43
1500	39	26	27	36	54	**141**	101	22	14	19	63	43	60	28	49	68	52	45
1600	38	28	**28**	33	41	136	90	24	15	20	**69**	45	59	28	43	63	**55**	44
1700	**45**	28	28	26	32	128	89	25	18	20	64	50	57	28	43	60	54	40
1800	39	27	24	24	34	123	86	24	25	19	57	54	55	26	45	55	53	40
1900	34	26	23	24	34	115	87	23	26	18	43	54	56	26	45	53	55	39
2000	34	25	23	23	50	112	81	23	26	17	33	55	51	27	45	50	53	41
2100	30	26	25	22	52	75	74	22	29	17	33	61	47	28	45	45	53	41
2200	26	23	28	25	40	72	62	22	25	15	38	58	49	30	48	44	54	44
2300	25	23	28	26	37	66	60	22	24	14	42	**62**	45	28	53	44	53	42

VI.5.4 Ozone (ppb)—Galveston

	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
TIME																		
0	39	36	**45**	**33**	27	27	24	26	35	12	7	17	56	47	20	24	36	16
100	39	36	SPN	32	27	SPN	20	33	34	SPN	4	17	SPN	37	7	24	36	16
200	36	30	SPN	33	27	SPN	11	29	27	SPN	14	24	SPN	36	7	23	36	15
300	29	24	38	33	29	14	11	29	25	16	11	24	33	36	9	24	35	14
400	29	22	32	32	29	13	9	29	32	13	7	18	37	33	9	21	33	14
500	27	19	31	30	28	13	8	21	38	10	8	19	35	31	3	10	33	12
600	11	11	33	27	25	15	11	23	25	12	9	12	34	15	3	11	34	11
700	22	20	37	29	29	19	12	24	40	13	9	19	32	22	9	19	33	14
800	31	30	36	29	29	23	15	31	42	15	11	32	43	32	13	26	35	13
900	34	40	36	25	**32**	27	20	40	60	19	27	84	59	40	16	35	37	12
1000	45	40	36	24	32	34	47	**54**	**65**	27	47	101	70	54	22	37	**38**	15
1100	51	36	34	24	32	35	66	54	65	38	76	119	74	68	30	43	37	**20**
1200	**56**	33	35	24	30	55	**82**	38	60	**46**	**145**	**133**	73	67	**31**	48	36	18
1300	50	38	32	27	29	86	77	36	54	43	77	110	73	**70**	28	46	36	12
1400	43	40	30	27	29	82	74	38	49	37	65	100	78	67	28	**50**	35	17
1500	43	38	31	26	29	**93**	76	36	51	36	73	111	77	61	29	44	35	19
1600	37	38	34	26	28	76	67	35	48	32	71	81	81	56	29	43	35	16
1700	33	39	23	30	28	64	58	37	44	29	64	75	**85**	55	22	40	33	16
1800	32	34	23	28	27	55	55	33	39	25	59	73	80	51	21	40	33	16
1900	33	34	26	28	27	41	52	30	32	22	54	58	75	44	18	39	31	17
2000	34	37	26	26	27	34	45	28	30	13	48	63	73	37	27	38	29	15
2100	35	44	27	26	26	31	42	23	24	12	44	58	72	33	25	39	28	13
2200	34	**46**	29	26	28	31	16	25	19	8	39	45	67	29	23	37	21	15
2300	32	45	32	FEW	28	27	19	30	14	5	27	53	59	25	24	37	16	15

VI.5.4 Ozone (ppb)—Galveston

TIME	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
0	15	21	19	1	55	59
100	15	17	20	0	53	SPN
200	18	22	18	0	51	SPN
300	17	25	13	0	48	23
400	21	23	12	0	41	30
500	23	24	28	0	32	30
600	19	29	18	0	29	21
700	30	24	22	4	34	32
800	36	FEW	15	18	37	39
900	38	24	14	22	45	50
1000	39	26	13	60	58	63
1100	34	28	19	70	74	67
1200	**40**	**31**	20	67	85	73
1300	39	28	40	63	**88**	77
1400	37	28	**52**	66	83	**89**
1500	37	28	46	66	84	84
1600	36	27	34	70	81	82
1700	31	26	32	**72**	82	80
1800	26	22	26	54	73	78
1900	26	CAL	22	49	67	78
2000	24	AQI	23	56	62	76
2100	23	23	19	49	61	65
2200	24	25	19	47	62	48
2300	22	24	10	46	60	30

VI.5.5 Particulate Matter (μg/m³)—Galveston

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	9.37	2.41	9.99	4.77	8.56	17.9	6.76	5.56	7.94	1.49	17.88	16.22	19.86	16.18	8.98	16.84	10.31	5.25
100	14.65	5.57	9.56	5.73	8.7	15.5	17.43	6.41	2.23	7.62	22.42	18.06	24.32	14.99	10.78	16.98	7.56	15.06
200	11.53	4.64	10.08	8.96	10.78	16.79	17.41	4.07	0.88	13.98	14.93	18.88	26.74	14.4	10.48	9.25	8.72	10.22
300	10.61	3.3	11.26	7.27	9.5	15.73	11.58	4.74	10.02	12.28	17.08	17.6	22.18	15.48	8.77	11.67	15.5	5.71
400	11.47	3.23	12.44	5.45	5.16	12.87	13.22	6.52	9.04	19.36	18.05	15.91	23.11	14.21	8.82	17.45	6.18	12.72
500	13.94	6.92	14.93	12.53	10.17	11.94	14.83	4.48	9.97	16.16	19.61	16.47	27.66	13.26	10.7	13.38	8.93	**18.09**
600	**15**	1.82	15.08	17.72	18.23	8.11	12.48	7.21	13.43	28.19	22.27	22.71	**39.25**	17.02	17.97	22.41	14.74	7.22
700	13.38	**13.54**	13.22	9.21	9.21	21.93	15.36	3.76	14.22	16.64	22.55	18.97	22.71	15.29	18.18	14.3	4.04	10.57
800	11.48	7.66	16.24	**18.7**	12.61	7.05	21.75	7.44	14.47	15.89	20.87	19.04	17.05	12.75	12	12.04	15.15	6.82
900	11.58	6.95	17.27	13.88	6.64	13.32	25.57	4.61	16.25	19.29	17.08	15.36	26.18	10.76	5.67	15.43	18.45	7.4
1000	13.78	7.85	**17.63**	14.54	11.96	12.65	19.5	3.1	18.72	18.36	20.68	17.91	21.11	15.74	19.33	18.07	7.93	7.25
1100	13.34	3.95	13.18	12.63	10.17	7.61	24.64	5.02	14.83	**30.75**	28.27	17.47	23.26	11.71	14.04	**24.02**	13.85	11.55
1200	12.6	4.49	17.51	13.73	10.44	22.89	24.79	7.66	15.7	19.09	**29.22**	18.62	20.39	12.51	14.24	14.32	5.21	6.92
1300	9.32	7.25	14.17	11.06	**29.95**	**30.14**	**36.19**	7.78	19.94	19.18	23.43	13.27	23.52	9.22	14	17.56	9.3	11.03
1400	10.96	4.02	11.97	11.11	14.86	23.52	22.52	9.15	16.74	15.11	22.26	17.53	19.85	5.85	21.56	17.62	14.15	0.68
1500	5.14	3.06	7.36	7.98	10.49	22.77	7.03	14.85	16	18.64	21.9	13.99	19.04	10.54	7.92	15.88	6.77	4.65
1600	7.24	5.61	13.71	11.6	5.75	23.8	23.15	**16.42**	14.42	16.3	13.28	16.81	24.07	9.83	16.39	6.54	**20.98**	6.43
1700	12.76	2.76	11.83	12.26	13.33	22.11	15.46	14.23	**23.28**	14.75	11.59	14.82	23.52	10.03	**26.46**	11.48	15.12	3.21
1800	8.72	6.26	11.07	6.2	8.55	21.27	21.7	7.33	1.36	15.94	18.63	16.91	17.56	2.61	5.37	9.33	11.37	5.72
1900	7.64	8.57	10.23	11.1	11.47	23.59	28.36	3.79	1.52	13.6	14.37	**24.26**	21.03	2.97	12.65	17.85	13.33	0.02
2000	5.99	6.29	11.88	7.93	3.19	22.89	27.05	5.65	4.3	17.49	17.46	18.88	15.35	10.28	16.64	11.41	5.27	0.13
2100	5.61	8.46	13.5	9.28	7.24	15.9	26.02	4.84	4.84	20.6	21.83	23.23	23.16	**17.16**	16.55	11.74	7.25	1.4
2200	4.95	12.66	12.74	8.62	20.82	13.05	13.26	10.54	9.82	13.42	19.18	18.33	7.26	9.1	15.92	16.81	8.6	6.55
2300	7.78	12.16	9.95	8.82	6.75	14.04	11.72	7.18	8.02	19.98	20.78	21.93	12.31	10.22	15.75	12.32	12.59	1.6

VI.5.5 Particulate Matter ($\mu g/m^3$)—Galveston

	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
TIME																		
0	4.8	4.56	6.43	8.4	9.66	2	4.87	11.89	5.96	0.75	18.63	4.99	26.76	5.79	**35.76**	5.86	7.36	5.13
100	0	4.46	10.35	8.84	10.02	5.34	3.6	7.25	15.95	2.76	14.4	10.28	68.27	2.62	2.63	4.95	6.37	1.52
200	2.52	6.34	3.13	7.14	11.96	9.33	4.73	14.77	8.1	5.08	11.66	8.75	**123.3**	1.36	4.17	1.63	10.91	3.87
300	3.36	5.65	8.47	6.38	5.14	4.6	2.87	12.59	7.02	5.6	13.2	13.71	42.25	2.64	1.02	2.2	16.29	4.03
400	5.01	4.38	6.45	10.63	12.66	1.41	4.68	13.38	5.87	2.06	7.15	4.8	47.25	0.98	6.25	7.15	21.86	1.92
500	6.47	3.28	5.19	14.52	10.23	4.23	2.98	15.81	10.26	4.16	4.26	3.8	53.7	1.53	9.94	2.17	17.02	6.76
600	5.11	**18.37**	14.1	15.56	**22.68**	8.36	5.18	13.05	12.15	4.55	6.95	6.7	39.56	11.67	14.57	13.11	9.02	1.78
700	10.29	2.31	10.73	13.06	13.94	9.85	2.47	13.7	8.48	4.03	6.86	26.23	44.52	1.74	22.86	5.19	**26**	13.69
800	5.07	4.38	7.86	8.52	15.06	6.79	1.07	13.52	12.14	0.12	3.32	32.99	56.52	1.99	9.11	16.01	10.77	**19.36**
900	4.93	4.79	12.14	4.9	8.73	AQI	7.4	11.45	2.5	4.57	9.95	23.81	65.32	0.82	14.46	2.27	5.24	14.12
1000	**10.84**	4.25	8.88	12.18	18.66	AQI	3.93	5.42	1.55	9.46	6.4	9.78	63.22	8.66	20.61	**18.83**	15.53	4.42
1100	4.83	4.28	4.34	8.25	9.02	16.05	1.56	**48.69**	**39.64**	14.9	9.7	14.16	51.97	12.92	19.45	5.35	11.09	3.19
1200	7.44	3.41	**16.84**	6.71	11.35	21.31	**43.4**	11.44	22.15	**58.78**	12.47	22.26	33.27	19.3	21.72	7.96	12.61	3.88
1300	6.41	12.89	7.13	7.64	8.28	**25.91**	34.06	8.9	13.66	28.68	**68.13**	17.98	24.08	12.03	14.37	13.84	12.32	2.43
1400	6.74	9.51	9.07	**16.98**	8.33	13.84	21.99	10.81	2.05	27.5	25.48	37.4	15.51	16.45	12.2	17.32	9.36	8.89
1500	5.88	4.98	9.05	9.18	6.74	14.47	24.21	16.21	8.9	13.17	28.33	**85.53**	16.01	10.41	17.2	9.02	12.3	5.68
1600	4.2	8.92	12.16	12.06	9.88	7.92	12.56	11.96	14.21	9.94	18.99	34.69	26.51	12.39	4.61	6.61	11.32	1.82
1700	0.9	5.05	5.6	11.49	12.09	14.72	22.75	15.33	11.69	10.73	21.82	39.55	40.63	16.16	3.66	14.07	10.57	4.52
1800	1.51	5.8	11.77	9.13	11.3	4.81	9.71	14.04	14.08	14.75	6.96	54.07	39.49	14.98	4.51	8.61	9.02	5.5
1900	7.33	7.78	13.4	6.62	6.49	7.01	6.09	9.84	11.73	33.33	15.13	39.83	18.21	13.91	2.68	8.93	8.94	1.39
2000	6.89	11.51	11.59	13.15	15.78	4.8	8.21	10.51	11.38	9.71	9.11	20.55	21.02	7.88	7.9	13.49	10.68	6.19
2100	1.72	8.08	7.5	7.09	8.27	5.67	15.08	10.42	10.02	14.6	14.57	31.49	18.1	13.76	1.68	4.63	13.44	2.15
2200	2.48	17.66	10.05	8.67	4.06	0.67	7.75	9.76	6.48	14.22	10.31	20.68	23.38	24.41	4.54	12.12	13.13	11.34
2300	5.48	5.64	10.99	FEW	14.6	2.71	12.86	17.27	3.72	12.66	15.1	19.76	22.08	**35.41**	5.78	15.88	5.25	6.45

VI.5.5 Particulate Matter ($\mu g/m^3$)—Galveston

TIME	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
0	1.08	1.62	0.77	5.55	6.59	7.57
100	0.67	3.94	1.31	7.47	7.04	8.08
200	2.13	2.42	1.23	10.41	7.72	12.44
300	2.9	1.28	1.01	9.2	9.84	11.85
400	3.01	4	3.21	12.54	8.79	10.89
500	2.85	4.05	0.75	13.21	8.89	10.78
600	**10.02**	1.37	3.35	16	8.89	9.95
700	3.3	2.58	3.35	18.2	11.96	13.69
800	6.64	FEW	3.92	12.16	13.3	13.38
900	7.12	**5.89**	5.31	5.35	12.91	11.88
1000	PMA	4.01	6.52	6.83	14.36	5.46
1100	PMA	4.78	5.98	5.82	14.74	4.59
1200	PMA	2.9	9.13	7.43	**14.87**	5.01
1300	2.99	1.49	**9.53**	8.13	14.37	8.55
1400	1.82	0.61	7.96	9.71	8.9	8.44
1500	1.75	0.5	6.71	9.13	8.6	9.47
1600	1.45	3.01	4.88	11.87	9.34	9.69
1700	1.44	0.38	3.58	11.34	12.37	9.13
1800	3.13	1.75	5.95	16.01	12.81	10.2
1900	1.94	3.68	7.25	18.36	13.6	13.6
2000	3.14	5.5	4.12	21.26	13.18	15.54
2100	2.86	2.25	5.81	**24**	14.06	15.63
2200	3.09	1.27	4.53	21.6	14.61	17.2
2300	2.25	1.96	3.8	16.57	11.26	**19.89**

VI.6 TNRCC DATA—HRM-3

VI.6.1 Temperature Data (°F)—HRM-3

VI.6.2 Wind Speed Data (mph)—HRM-3

VI.6.3 Wind Direction (0-359 degrees)—HRM-3

VI.6.4 Ozone (ppb)—HRM-3

VI.6.1 Temperature Data (°F)—HRM-3

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	80.8	83.5	82	81.2	80.8	77.6	80.6	83.3	83.8	81.2	81.4	81.1	81.1	79.8	81.3	83.8	82.8	80
100	80	82.9	81.4	80.9	80	77.6	79.5	81.8	83.4	80.4	80.3	80.3	81.1	79.7	81.2	82.9	81.5	79.1
200	79.9	82.5	81	80.1	79.2	77.3	78.1	81	82.8	79.7	79.3	80.4	80.9	79.2	80.7	82.4	80.7	78.5
300	80.1	82.4	80.9	79.5	79.4	76.6	76.7	81.9	82.4	78.9	78.9	79	79.8	79	80.5	82.3	79.1	77.7
400	79.6	82.1	80.4	77.8	79.2	75.9	78	80.7	81.8	78.3	78.5	77.9	77.7	78	80.5	80.8	77.7	77.2
500	77.9	82.3	80.4	77.3	78.6	75.3	76.2	79	80.8	78.3	78.7	77.3	77.3	76.8	79.6	79.2	76.5	76.8
600	79.3	83.4	80.8	77.2	79.2	76	76.9	79.7	81	79	79.5	77.8	77	77.7	79.2	79.2	76.3	77.2
700	83.3	84.8	84.3	80.7	81.3	79.2	83.1	84.1	84.4	82	81.7	81.3	81.6	80.8	82.6	82.1	78.3	80.9
800	86.2	87.1	86.4	83.4	84.1	83.3	86.4	87.6	86.8	85.8	85.2	84.2	85.3	84.2	84.8	85.6	81	84.9
900	87.7	89.3	88.9	86	87.5	86.2	89.5	88.7	89.1	88.4	88.6	87.3	88.2	88.5	87.5	87.2	78.5	85.8
1000	87.6	90	91.5	89.9	90.8	90	92.8	91.8	90	91.1	91.7	90.3	90.5	90.8	90.9	86	77.7	89.6
1100	89.8	90.5	92.8	92.8	93.1	92.2	95.2	92.8	90.7	93.3	94.5	93.2	93.3	93.6	94.1	84.7	81.7	**91.5**
1200	91.1	88.6	92.6	94.8	95.8	94.5	96.7	93.2	93.5	96	97.5	95.4	95.2	95.1	95.3	84.8	84.2	90.8
1300	**92.6**	91.7	**93.8**	96.7	97.5	96.6	97.1	**93.9**	93.6	97.7	98.8	96.9	**97**	96.7	96.2	86.3	85.1	84.6
1400	92.5	**92.3**	93.3	**97.2**	98.8	97.6	**97.3**	93.3	93.8	99.1	**99.1**	**97.7**	96.8	**98**	**97.3**	88.1	85.7	79.3
1500	92.4	91.6	93.1	96.5	**99.8**	**97.8**	97.1	92.2	**94.6**	**99.5**	99.1	97	95.9	97.2	97	89.7	87.1	78.9
1600	91.7	90.5	92.8	96	99.5	97.5	94.6	91.8	94.3	96.9	97.9	95.7	94.5	95.5	96.1	**90.6**	**87.9**	79.5
1700	90.2	88.6	90.4	94.7	98.7	96.2	92.5	90.2	92.5	94	95.1	94.5	92.7	92.8	91.9	89.4	87.5	79.8
1800	87.4	86.6	87.9	92.3	87.5	93.9	89.2	87.9	88.2	91.6	92.5	91.8	89.8	90	88.9	86.9	85.7	79.5
1900	86.1	85	85.7	88	81.6	84.1	86.4	86.6	86.7	88.5	88.7	88.2	86.1	87	87.2	84.9	83.9	78.2
2000	85.5	83.7	84.3	85.7	78.9	84.8	85	85.6	84.4	86.7	85.9	85.3	84	84.8	85.8	84.4	83.8	77.5
2100	84.6	83.2	83	83.9	78.5	84	83.7	84.7	83.1	86.1	83.8	83.9	82.5	83.6	84.9	84.1	83.2	77
2200	84	82.7	81.9	82.7	78	84	82.9	83.8	82.4	84.7	82.4	82.4	81.2	82.6	84.7	83.5	82.1	76.5
2300	83.5	82.5	81.3	81.5	77.9	82.3	83.3	84.1	81.8	83	81.6	81.9	80.5	82	84.3	83.5	81.1	78.9

VI.6.1 Temperature Data (°F)—HRM-3

	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
TIME																		
0	78.8	81.1	80.9	81.6	80.9	81.8	83.6	87.6	84.5	83.9	87.5	85.8	LST	80.5	75	76.5	83	82.5
100	77.4	80.8	80.2	81.1	80.7	80.3	82.5	86.2	83.5	83.3	85.9	84.7	LST	80.8	74.1	76.6	82.7	81.7
200	76.5	79.1	80.5	80.5	80.2	79.8	81.5	83.2	82.3	82.9	84.6	82	LST	79	73.7	76.6	82	80.5
300	75.4	77.4	80.3	80.7	80	79.1	80.8	82.7	81.8	82.5	82.8	81	LST	77.9	73	76.7	81.1	80.4
400	75	76	78.8	79.5	78.6	78.3	80.2	83	82.4	82.6	81.6	80.1	LST	76.7	72.6	76.6	79.8	80.5
500	74.8	75.3	78.1	77.9	78.1	78.5	79.7	82.4	81.5	82	82.9	79.8	LST	76.2	72.3	76.3	79.9	80.5
600	75.6	76.7	79.1	78.3	77.1	78.9	80.5	81.8	81.7	81.7	82.2	80.4	LST	75.6	72.6	76.2	79.9	81.7
700	79.6	81.4	81.8	83.1	82	81.4	84.4	84.5	84.3	84.5	85.6	85.7	LST	77.7	74.5	77.2	81.8	82.1
800	83.7	84.6	85.1	86.2	85.2	85.1	88.5	88.4	87.3	87.7	90.6	90.6	LST	80.2	77.8	80.5	85.3	85.5
900	86.7	88.1	88.8	89.2	89.3	89.2	93.3	90.9	89.8	91.5	95.3	94.4	LST	83	81	83.3	88.2	85.5
1000	89.2	90.8	91.1	90.5	92.1	93.1	98.2	94.4	94.1	94.9	100.7	99.7	LIM	85.9	82.6	84	90.1	82.6
1100	89.7	93	93.7	94.3	94.6	96.3	101.5	98.3	97.7	98.6	104.4	103.7	LIM	89	84.8	85.7	**91.4**	80.3
1200	92.4	94.4	**95.6**	96.2	96.8	99.1	104	101.9	100.4	101.6	107.3	105.3	90.6	90.7	85.8	87.6	90.8	83.1
1300	93.3	**94.9**	94.9	**97.1**	98.2	101.2	105.4	104.5	102.3	103.7	**108**	**106.7**	92.5	**92.1**	85.4	**88.5**	90.1	86.9
1400	**95.4**	94.9	95	96.4	**99.7**	102.5	106.4	**105.8**	103.1	105.2	107.7	105.9	93.8	91.8	**86.2**	88.3	91.1	88.8
1500	94.5	94.8	94.4	96.2	98.9	**103.7**	**106.9**	105.8	**103.5**	105.2	107.3	92	**94**	91.4	86.1	88.2	81.9	**90**
1600	93.3	94.3	93.5	94.6	96.8	103.3	105.8	104.8	103.2	**105.3**	105.6	91.5	92.6	90.2	85	87.5	83.9	90
1700	91.1	92.1	91.7	92.6	94.2	101.5	104.5	84.9	99.6	103.8	102.5	95.4	91.3	86.9	83.2	85.5	88.2	88.8
1800	88.3	89.4	88.8	89.3	90.5	96.1	102.1	81.2	96	101.8	98.8	LIM	88.2	83.8	80.5	82.8	86.8	86.3
1900	86.3	86.6	86.4	86.6	87.1	91.1	99.1	83.1	93	99	95.8	PMA	86.6	81.3	77.5	82.3	84.9	84.5
2000	84.4	84.2	84.6	84.8	85.2	88.9	95.1	83	91.4	93	92.4	PMA	85.5	79.2	77.2	82	83.6	83.8
2100	83	82.8	83.8	83.3	84.2	87.6	92.5	82.9	89.1	91.2	90.8	PMA	84.1	77.2	76.6	82	83.4	83
2200	82.1	81.9	82.8	82.3	83.2	86.5	90	81.5	87.3	90.6	89.8	LST	82.8	76.1	76.3	83	83	82.4
2300	81.4	81.2	82.1	81.5	82.2	85	88.4	85.1	85.3	89.1	87.5	LST	81.8	75.7	76.6	83.1	83.2	81.8

VI.6.1 Temperature Data (°F)—HRM-3

	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
TIME						
0	81.2	77.9	78.1	75.6	76.3	68.9
100	80.9	80.4	77	75.1	74	69
200	81	79.6	76.6	74.9	73.2	66.1
300	81	78.7	75.6	74.8	72.6	65.2
400	80.5	78.1	75.3	74.3	70.4	65.8
500	80.5	77.1	75.2	73.8	68.8	65
600	80.8	76.8	75.4	74.5	67.5	64.2
700	83	76.8	76.8	78.1	69.1	66.7
800	86	76.7	79.6	82.1	71.8	71
900	86.8	77.2	83.7	86.1	75.5	75.4
1000	88.4	77.1	85.1	88.6	79.3	79.5
1100	90.6	75.7	86.9	90.1	82.3	82
1200	**93.1**	75.3	**87.1**	91.9	84.7	84
1300	90.7	75.4	83.8	92.8	86.4	85.9
1400	91	78.9	84.6	**92.9**	87.8	87
1500	91	**81**	84.4	92.8	**88.2**	**87.6**
1600	89.5	79.5	84.3	91.8	87.7	87.2
1700	87.1	78.2	84.6	91	85.7	85.5
1800	85.7	77.4	81.5	88.8	81.3	79.3
1900	85.1	77.7	80	86.1	79.1	74.2
2000	81.6	78.2	78.5	83.7	77.1	71
2100	79.5	78.8	77.2	81.8	75.8	69.7
2200	79.3	78.8	76.8	79.9	73	67.2
2300	77.4	78.5	76	78.3	68	67

VI.6.2 Wind Speed Data (mph)—HRM-3

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	5.1	6.5	7.2	5.2	5.2	1.1	1.8	7	6.3	3.4	5.4	6.5	6.3	4.6	4.1	**7.4**	2.3	0.2
100	4.2	5.6	6.3	4.1	5.2	0.4	1.4	5.1	6.1	2.5	4.1	3.3	5	7	4.3	5.3	2.9	0.8
200	4.2	5.4	5.7	3.8	4.4	0.8	1.6	2.9	5.7	2.2	5.1	3.8	5.2	6.1	5.2	4.1	1.9	2.7
300	4.1	4.8	4.1	3.6	5	0.9	1.8	3.6	6.6	2.3	4.3	2.3	3.5	4.7	4.5	3.4	2.8	2.5
400	3.6	3.9	3.8	3.7	5	0.9	3.4	1.3	5.1	2.9	3.8	1.1	2.3	3.5	5	0.8	3.4	2.5
500	1.7	6	2.6	2.9	1.7	0.7	2.1	1.7	3.1	2.3	4.4	2	1.2	1.2	3.7	1.4	3.2	2.6
600	1.2	6.7	0.7	1.9	6.1	1.2	0.7	2.1	0.9	2.5	5.5	3.2	1	2.3	2	3.3	2.5	2.6
700	4.2	6	4.3	1.4	7.3	2.5	4.1	2.5	4.2	4.7	9.2	3.1	2.3	1.3	3.8	5.2	4.8	1
800	5.2	7.9	6.1	2.4	**8.8**	2.5	5.2	5.4	6	5.2	7.4	3.3	3.7	2.2	3.4	6.1	1.7	3.1
900	4.2	7.4	4.9	1.6	6.5	1.7	6.4	7.8	5.4	5.5	6.3	4.1	3.3	5.2	3.1	7.3	4.3	2.1
1000	3.8	4.4	4.6	1.6	2.7	3.2	5.3	9.3	6.1	3	4	3.2	3.4	4.9	3.6	1.9	3.7	4.1
1100	6.3	9	4.2	3.4	2.8	3.1	6.4	10.4	5.4	3.2	0.7	3.5	3.6	3.7	1.8	1.4	3.2	3.8
1200	8.2	12.1	6	2.1	2.9	3.4	5.4	10.3	9.4	4.1	3.7	4.1	3.6	3	4.6	2.5	3.1	3
1300	10	**12.8**	7.9	3.1	2.8	3.6	5.4	11.8	10.2	4.2	3.9	4.4	2.9	3.5	6.9	3.1	2.8	**8.2**
1400	9.7	11.8	**8.8**	3	3.2	3.9	5.7	11.6	**12.4**	4.4	5.6	6	6.3	6.6	6.3	5.3	4.2	5.3
1500	10.4	12.2	7.6	7.3	4.2	4.2	6.4	12.4	11.1	2.1	8.4	**10.5**	10.2	7.9	7.3	4	4.6	4.6
1600	**11.4**	10.7	8.2	7.1	3.7	4.8	**9.6**	**12.9**	9.1	9.5	9.9	9.6	**10.3**	9.3	10.2	6.5	4.4	3.2
1700	10.3	11.1	7.6	6.7	6.3	6.4	8.5	11.7	5.8	**11.2**	**10.9**	10.3	9.8	**11.2**	10.3	7	5.2	3.6
1800	7.7	8.8	6.4	8.7	5.5	5.8	7.1	10.7	6.8	9.8	9.8	8.7	9.3	10.8	**11.3**	6.4	4.4	1.6
1900	10.2	9.8	7.9	**9.1**	8.6	**6.9**	6	8.9	10.1	7.5	9.3	8.6	9.7	9.9	8.2	5.9	5.7	0.4
2000	9.3	7.5	7	7.4	2.5	4.4	4.9	8.2	9.4	7.9	8.8	6.9	9.2	8.1	7.6	6	**5.9**	0.4
2100	6.1	7.4	6.8	6.5	4.2	3.5	4.6	3.7	5.9	7.6	7.4	7.2	6.6	7	7.6	6.4	3.8	0.6
2200	7.1	9	6.5	7	1.2	3.9	4.3	3.1	5.5	6.7	6.6	5.5	5.4	5.4	5.3	4.6	3.1	0.2
2300	6.7	8.3	5.3	5.7	1	3.2	4.7	6.5	4.8	6.4	5.3	6.5	5	4.9	5.7	3.7	0.6	4.9

VI.6.2 Wind Speed Data (mph)—HRM-3

	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
TIME																		
0	3.3	4.5	5.4	5.6	4.8	4.8	3.3	4.7	5.9	5.6	4.8	1.4	LST	1.4	4.2	3.4	7.5	5.5
100	0.4	4.1	3.9	5	6.2	3.6	2.7	3.8	4.7	6.1	3.6	0.9	LST	3.5	4.4	2.8	6.5	5.5
200	0.3	2.8	4.5	4.3	4.4	3.8	2.9	1	4.7	5.6	5	0.6	LST	3.8	3.9	2.1	6.3	5.2
300	1.8	1.1	4.5	3.6	2.2	4.1	3	1.6	3.5	5.8	4.6	0.5	LST	4.5	5.2	2	4.4	4.7
400	2.9	0.4	0.5	0.8	1.9	3.5	2.2	4.8	6.4	6.4	4.6	0.6	LST	3.8	4.4	3.3	1.9	3.5
500	2.2	0.9	1.9	0.4	1.3	3.5	3.4	3.6	4.8	6.4	8.3	0.4	LST	3.5	3.8	3.1	1.6	2.8
600	2.6	1	2.2	0.8	0.6	4.3	5.2	4	3.9	4.5	7.4	0.6	LST	1.9	4.1	2.9	2.7	4.7
700	3.1	2.9	0.9	0.4	1.4	5.5	8.6	8	5.3	7	7.2	3.1	LST	3.6	5.9	2.5	1.2	3.4
800	2	2.7	3.1	3.5	2.5	8.8	**8.7**	8.7	9.4	**8.9**	9.4	5.6	LST	5	6.5	0.7	4.7	5.1
900	1.2	3	3.8	4.7	3.5	8.1	8.5	7.8	8.2	8.6	**9.4**	6	LST	5	7	0.5	4.5	3.1
1000	3.3	3.4	5.6	3.7	3.9	7.2	7.3	7.9	6.3	7.4	7.5	5.6	FEW	6.7	6.7	0.4	4.8	2.5
1100	2.7	3.4	5.6	6	3.7	5.4	6.1	6.7	6.9	6	6	5	3.1	6.3	**7.2**	3.4	4.4	3.5
1200	4.8	3	5.9	6.1	2.6	3.5	3.2	5.8	4.8	5.8	5.2	5.6	5.1	7.1	6	3	8.7	4.8
1300	4.9	5.4	9.7	6	4	3.6	1.1	6	4.1	5.1	5.9	**6.3**	4.8	7.1	6.1	7.6	6.1	6.4
1400	6.7	7.2	9.9	10.3	4.3	0.8	1.7	7.6	1.8	2.7	7.2	4.2	5.1	5.9	5.5	9.2	7.3	7.9
1500	7.5	8.2	10.8	11.1	6.3	1.1	4.2	7.4	3.9	3	5.7	5.9	4.5	6	5.9	10	5.1	**10**
1600	9	9.1	**11.4**	**11.8**	9.8	3.5	5	5.8	2.5	3.9	8.2	3	5.3	**8.8**	6.1	**11**	2.2	8.9
1700	**9**	9.7	10.6	11.2	9.2	6.3	6.6	**12.8**	7.4	3.6	8.8	1.8	2.8	8.6	6.8	9.4	7.2	9
1800	7	9.1	10.2	9.9	**10**	**9.1**	4	6.4	**10.3**	5.1	8.8	1.7	2.4	6.9	5.1	8.2	**11**	8.7
1900	7.4	**9.9**	10.2	9.3	8.4	7.9	6	3.8	8.9	1.9	6.7	PMA	**6.1**	6.9	3.9	8.3	10.3	7.5
2000	7.8	7.2	8.1	8.2	5.2	7.4	7.7	0.2	8.4	1.7	5.8	PMA	5.4	6.5	3.4	6.1	7.5	8
2100	6	5.9	6.9	6.4	6.1	6.2	6.4	3.2	7.4	1.9	4.2	PMA	3.6	5.4	3.6	4.6	7	6.9
2200	5	5.9	6.8	5.9	6.4	5.2	4.3	0.8	8.2	4.8	3.6	LST	1.6	4.2	3.2	7	6.2	5
2300	4.8	4.2	6.3	4.6	4	4.5	4.7	6.2	6.4	5.2	1.1	LST	0.9	4.4	3.2	7.2	7.2	5

VI.6.2 Wind Speed Data (mph)—HRM-3

	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
TIME						
0	4.5	2.4	2.6	2.9	2.4	3.2
100	4.2	**7.7**	3.5	4.2	2.8	3.6
200	4.9	5.4	3.5	3.4	3.1	2.6
300	6.1	3.7	3.7	3.1	3.1	2.8
400	5.2	5.6	3.6	3	3.3	4
500	5.7	5.1	2.7	4.5	4.4	4.1
600	4.2	2.6	3.7	4.2	6	4.4
700	4	4	2.4	5.4	7.7	5
800	3.1	3.4	2.2	6.6	7.4	4.8
900	2.6	3.6	1.8	**7.7**	**7.7**	4.1
1000	2.5	4.5	2.3	6	6.8	4.1
1100	1.9	1.3	3.8	5.5	7.7	5.4
1200	3.3	1.5	**5.2**	6.5	7.2	4.8
1300	**8.8**	2.2	2	5	6.8	**5.5**
1400	7.4	3.1	3.7	4	6.1	5.1
1500	7.4	4.7	3.9	4.3	6.6	4.6
1600	8.5	2.8	2.3	3.3	6	3.2
1700	6.6	1.6	3.3	5	3.4	2.9
1800	4.9	1.3	1.9	5.8	2.6	3.2
1900	6	2.8	3.6	6.6	3.4	2.1
2000	5.5	2.5	3.5	6.7	2.9	0.3
2100	5.1	2.6	2.1	5.5	2.7	0.7
2200	3	3.1	3.5	4	2.2	LIM
2300	2.9	2.6	4.2	3.3	2.1	LIM

VI.6.3 Wind Direction (0-359 degrees)—HRM-3

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	193	176	177	189	233	81	244	138	172	231	238	195	193	197	191	186	**183**	37
100	192	176	188	222	256	**354**	273	122	178	240	247	203	215	198	198	202	97	19
200	195	178	195	230	262	21	345	116	169	240	254	207	220	193	202	196	71	12
300	188	152	203	245	265	17	**359**	125	181	275	250	262	238	200	202	203	39	29
400	197	**184**	**215**	285	285	54	336	83	185	278	259	285	290	252	216	**351**	37	22
500	210	134	200	294	302	10	342	**354**	201	274	262	285	270	275	242	18	25	11
600	**229**	141	166	19	291	36	332	23	193	262	282	**294**	**307**	297	283	28	21	18
700	191	144	154	**355**	291	44	319	56	134	276	280	265	257	**326**	283	22	22	11
800	184	162	176	267	295	25	327	101	150	262	287	256	257	274	312	12	30	321
900	118	152	165	257	290	7	5	131	161	283	**293**	254	210	254	**344**	12	91	327
1000	111	170	186	270	228	3	13	127	120	276	287	205	220	262	20	18	46	**350**
1100	114	133	150	177	240	40	50	135	116	290	261	194	202	241	168	277	57	319
1200	128	142	120	256	207	50	64	133	133	274	185	204	214	257	118	14	84	150
1300	134	141	145	208	245	76	71	133	135	213	166	196	184	161	118	33	90	186
1400	133	171	119	180	264	68	88	137	141	233	123	150	147	158	130	28	92	86
1500	136	169	118	125	207	99	111	132	161	**305**	131	135	143	155	139	75	92	102
1600	144	173	129	143	202	129	132	140	161	139	140	131	140	142	130	123	103	99
1700	143	174	124	158	173	146	127	142	135	145	142	155	141	142	129	121	106	97
1800	131	159	125	176	69	123	128	140	123	157	150	168	166	167	142	129	113	108
1900	146	140	137	187	135	148	130	138	152	163	175	176	182	176	147	129	130	75
2000	150	149	175	184	17	192	124	133	175	185	173	181	185	186	179	126	127	35
2100	169	166	177	188	297	197	126	120	185	199	189	175	188	190	179	129	157	304
2200	181	177	188	196	**313**	227	130	128	193	224	188	192	189	195	159	124	113	1
2300	183	173	186	224	73	265	132	133	**215**	231	203	188	190	199	181	117	140	195

VI.6.3 Wind Direction (0-359 degrees)—HRM-3

	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
TIME																		
0	210	210	194	196	197	238	259	246	237	243	243	276	LST	64	53	41	140	166
100	**277**	220	205	207	194	272	260	251	245	251	235	270	LST	77	44	33	149	189
200	207	259	201	194	191	268	262	269	261	254	224	271	LST	82	46	256	183	207
300	1	**306**	195	216	217	266	271	266	249	265	241	266	LST	78	50	35	198	200
400	27	10	285	259	285	260	270	253	245	279	280	5	LST	73	57	23	191	189
500	44	3	290	**348**	**298**	266	260	257	247	280	284	**310**	LST	62	48	29	190	192
600	34	5	293	35	17	302	283	270	244	267	292	21	LST	43	38	34	194	192
700	23	296	**293**	294	293	306	297	276	244	269	296	7	LST	57	20	40	208	**233**
800	30	256	198	203	228	302	299	272	263	274	301	16	LST	65	25	34	188	199
900	61	212	208	197	236	298	303	276	262	275	305	18	LST	29	19	**272**	200	205
1000	40	208	177	212	217	**311**	306	257	276	276	**325**	8	FEW	28	33	192	190	33
1100	62	168	193	165	268	302	289	256	**297**	266	18	18	49	29	33	81	181	70
1200	128	173	159	169	215	280	**328**	258	290	279	13	20	30	31	53	110	123	74
1300	113	117	142	152	222	282	50	232	271	277	50	26	104	38	65	116	151	137
1400	149	119	133	134	175	8	236	224	249	**282**	73	48	89	62	69	132	166	144
1500	137	135	131	142	148	33	193	240	220	239	72	48	91	70	68	132	**271**	150
1600	137	153	148	141	148	141	204	257	209	229	130	103	113	**105**	61	141	15	138
1700	144	140	169	158	166	145	185	9	140	265	139	82	107	103	69	140	147	140
1800	133	157	170	176	179	176	211	**351**	174	241	142	55	111	101	**73**	127	145	164
1900	161	170	172	171	185	191	203	203	203	215	165	PMA	122	87	63	136	147	156
2000	188	182	175	176	187	195	222	73	215	84	187	PMA	**128**	86	56	127	179	169
2100	189	194	168	188	196	211	233	80	216	233	201	PMA	118	85	51	117	156	169
2200	195	193	183	193	206	233	248	120	231	253	206	LST	77	79	42	141	165	163
2300	195	194	190	194	237	252	246	190	230	258	278	LST	50	73	41	139	164	181

VI.6.3 Wind Direction (0-359 degrees)—HRM-3

	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
TIME						
0	199	81	48	330	53	34
100	200	136	24	343	42	40
200	198	127	17	315	47	35
300	187	80	24	315	48	36
400	198	90	29	320	39	41
500	192	83	27	300	26	39
600	186	69	29	316	24	36
700	**210**	21	75	340	29	36
800	149	49	49	350	26	30
900	123	**337**	42	352	26	48
1000	112	30	121	350	29	43
1100	126	18	132	354	26	33
1200	107	306	129	22	22	28
1300	109	8	276	**355**	31	26
1400	120	69	3	331	30	17
1500	113	97	84	330	25	20
1600	126	88	88	304	32	72
1700	125	96	38	13	**65**	89
1800	113	73	351	24	45	97
1900	117	78	334	27	43	109
2000	54	73	356	32	40	159
2100	77	77	**359**	38	52	**331**
2200	30	78	335	61	55	LIM
2300	14	74	304	60	34	LIM

VI.6.4 Ozone (ppb)—HRM-3

	07-Aug	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug
TIME																		
0	9	12	11	9	7	2	41	16	4	8	9	AQI	30	19	10	13	12	7
100	7	6	7	8	10	2	37	20	9	5	4	AQI	27	24	10	21	10	4
200	5	7	SPN	5	7	2	SPN	21	7	SPN	7	AQI	28	SPN	14	21	SPN	3
300	5	3	SPN	5	11	2	SPN	25	11	SPN	9	AQI	17	SPN	13	27	SPN	3
400	6	4	11	5	6	2	16	10	12	6	5	AQI	22	12	8	15	5	3
500	4	3	6	2	2	2	11	2	11	3	4	AQI	20	12	7	3	2	3
600	3	7	4	2	4	3	10	3	7	4	4	AQI	5	6	4	3	3	3
700	12	11	7	5	6	17	32	8	8	9	7	AQI	21	11	11	9	6	7
800	17	15	16	9	11	47	43	22	12	12	8	AQI	40	22	8	22	11	33
900	18	19	22	20	12	94	56	22	16	12	13	AQI	54	31	12	35	18	47
1000	27	**26**	32	55	17	92	66	24	19	17	19	AQI	71	37	26	44	17	58
1100	35	25	37	87	30	100	62	**27**	22	26	**33**	CAL	74	44	38	49	26	**71**
1200	**42**	21	48	97	47	**104**	64	26	**31**	38	QAS	CAL	73	54	104	43	38	71
1300	42	22	**51**	93	64	80	69	26	30	**54**	AQI	CAL	74	56	**114**	45	**88**	69
1400	39	21	50	100	88	70	70	26	23	QAS	AQI	**69**	**81**	60	92	52	51	40
1500	36	21	44	**113**	101	71	75	26	17	QAS	AQI	68	71	**67**	102	56	49	25
1600	32	20	28	90	**105**	79	**83**	23	16	CAL	AQI	53	56	49	68	**58**	58	20
1700	23	17	24	70	98	67	78	13	14	CAL	AQI	43	53	29	42	46	42	23
1800	18	12	12	40	53	48	70	9	8	CAL	AQI	42	38	18	26	38	30	18
1900	15	8	2	18	38	30	50	7	5	6	AQI	29	31	16	19	34	30	11
2000	11	5	4	9	28	32	37	10	12	7	AQI	21	26	12	15	33	24	4
2100	4	1	6	6	16	27	31	11	10	7	AQI	19	28	13	15	36	13	3
2200	3	10	5	12	14	35	35	8	10	2	AQI	18	21	10	12	29	23	3
2300	6	11	5	8	7	46	13	5	9	9	AQI	22	15	10	8	23	13	15

VI.6.4 Ozone (ppb)—HRM-3

	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep
TIME																		
0	12	16	17	10	9	15	13	29	15	8	11	36	LST	AQI	AQI	5	10	11
100	6	13	13	11	14	13	11	30	18	10	5	14	LST	AQI	AQI	5	15	10
200	6	7	SPN	5	13	SPN	6	20	19	SPN	1	0	LST	AQI	AQI	6	SPN	14
300	2	5	SPN	7	6	SPN	3	13	17	SPN	4	0	LST	AQI	AQI	3	28	11
400	2	3	10	4	2	5	1	17	23	16	19	0	LST	AQI	AQI	2	9	11
500	2	2	3	2	2	5	1	13	18	13	5	0	LST	AQI	AQI	2	8	4
600	3	3	10	2	2	3	2	5	17	9	3	0	LST	AQI	AQI	3	15	5
700	8	10	13	8	5	5	6	12	18	12	15	2	LST	AQI	AQI	5	26	7
800	20	19	26	23	13	11	13	QAS	31	16	34	19	LST	AQI	AQI	17	29	24
900	36	27	36	31	27	16	24	23	39	23	69	65	LST	AQI	AQI	18	38	22
1000	74	59	41	40	34	29	37	39	50	36	59	87	AQI	AQI	AQI	23	40	15
1100	106	46	46	44	42	44	60	56	67	56	86	93	AQI	AQI	AQI	36	42	18
1200	**119**	55	**48**	46	55	63	82	76	81	75	**92**	107	AQI	AQI	AQI	**81**	**48**	21
1300	114	**80**	47	**51**	83	76	97	96	87	87	86	101	AQI	AQI	AQI	53	40	19
1400	68	76	42	45	**101**	85	118	**98**	92	92	75	**130**	AQI	AQI	AQI	44	36	19
1500	52	67	37	41	87	88	134	98	100	97	75	107	AQI	AQI	CAL	41	36	**28**
1600	41	50	27	32	63	106	**157**	84	**104**	**98**	76	77	AQI	AQI	CAL	31	27	20
1700	29	34	24	23	48	**108**	134	62	62	96	75	87	AQI	AQI	CAL	21	24	10
1800	11	20	17	15	30	65	98	38	31	72	LIM	54	AQI	AQI	**15**	22	18	7
1900	11	17	14	13	19	35	55	23	33	54	47	PMA	AQI	AQI	9	10	14	5
2000	19	13	12	12	12	26	32	7	23	37	61	PMA	AQI	AQI	5	7	15	6
2100	18	14	8	12	19	14	36	18	23	16	59	PMA	AQI	AQI	7	18	10	6
2200	14	12	7	13	11	12	17	3	15	12	41	LST	AQI	AQI	6	9	12	5
2300	12	8	7	8	6	18	23	13	12	8	36	LST	AQI	AQI	5	9	13	5

VI.6.4 Ozone (ppb)—HRM-3

	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep
TIME						
0	4	6	2	3	32	27
100	4	6	2	9	24	45
200	4	SPN	3	2	31	SPN
300	5	SPN	2	2	34	SPN
400	6	10	2	2	30	35
500	3	7	2	2	16	32
600	3	4	2	2	13	29
700	11	4	4	6	28	37
800	17	5	7	13	33	39
900	15	5	21	21	40	52
1000	37	7	35	30	49	**67**
1100	58	7	46	35	55	62
1200	**62**	4	**47**	47	61	58
1300	40	QAS	40	56	**62**	60
1400	33	QAS	37	66	62	62
1500	41	**26**	28	**68**	61	62
1600	25	18	21	61	58	59
1700	18	5	20	48	55	57
1800	23	3	12	50	36	50
1900	17	5	7	44	34	18
2000	20	3	7	41	23	5
2100	20	5	3	40	36	8
2200	13	9	3	41	30	2
2300	10	3	2	36	8	1

VI.7 SPECIATE DATA

VI.7.1 Profile—Forest Prescribed Burning-Broadcast Conifer

VI.7.2 Profile—Meat Cooking-Charbroiling

VI.7.3 Profile—Meat Cooking-Frying

VI.7.4 Profile—Vegetative Detritus

VI.7.1 Profile—Forest Prescribed Burning-Broadcast Conifer

	PM 2.5 %	**UNCERTAINTY**
CONSTITUENT		
Nitrates	0.359	0.23
Sulfates	0.167	0.06
Organic Carbon	64.858	4.315
Elemental Carbon	6.942	4.393
Aluminum	0.046	0.018
Silicon	0.054	0.017
Phosphorus	0.06	0.025
Sulfur	0.171	0.116
Chlorine	0.239	0.179
Potassium	0.782	0.639
Calcium	0.072	0.039
Titanium	0.004	0.002
Vanadium	0.001	0.001
Chromium	0.002	0.001
Manganese	0.011	0.007
Iron	0.009	0.003
Nickel	0.002	0.001
Copper	0.002	0.002
Zinc	0.046	0.028
Bromine	0.009	0.006
Silver	0.019	0.009
Cadmium	0.031	0.015
Tin	0.018	0.015
Lead	0.01	0.009

VI.7.2 Profile—Meat Cooking-Charbroiling

CONSTITUENT	PM 2.5 %	UNCERTAINTY
Aluminum	0.08	0
Silicon	0.11	0
Phosphorus	0.1	0
Potassium	0.16	0
Calcium	0.057	0
Titanium	0.01	0
Vanadium	0.003	0
Chromium	0	0
Manganese	0	0
Iron	0.071	0
Nickel	0.007	0
Copper	0.34	0
Zinc	0.22	0
Arsenic	0.002	0
Selenium	0.001	0
Bromine	0.009	0
Rubidium	0	0
Strontium	0.004	0
Barium	0.2	0
Lead	0.027	0
Elemental Carbon	0	0
Organic Carbon	58.8	0
Magnesium	0.91	0
Sodium	0.23	0
Chlorine	0.37	0
Nitrates	0.02	0
Sulfates	0.21	0
Ammonium	0	0

VI.7.3 Profile—Meat Cooking-Frying

	PM 2.5 %	UNCERTAINTY
CONSTITUENT		
Aluminum	0	0
Silicon	0	0
Phosphorus	0	0
Potassium	0.36	0
Calcium	0.15	0
Titanium	0	0
Vanadium	0	0
Chromium	0.15	0
Manganese	0.041	0
Iron	0.24	0
Nickel	0.049	0
Copper	0	0
Zinc	0	0
Arsenic	0	0
Selenium	0.006	0
Bromine	0.084	0
Rubidium	0.09	0
Strontium	0.01	0
Barium	0.46	0
Lead	0.2	0
Elemental Carbon	0	0
Organic Carbon	57.4	0
Magnesium	0	0
Sodium	0.45	0
Chlorine	3.52	0
Nitrates	2.08	0
Sulfates	0.91	0
Ammonium	0	0

VI.7.4 Profile—Vegetative Detritus

CONSTITUENT	PM 2.5 %	UNCERTAINTY
Aluminum	2.57	0
Silicon	8.35	0
Phosphorus	0.3	0
Potassium	1.67	0
Calcium	2.29	0
Titanium	0.27	0
Vanadium	0.018	0
Chromium	0.054	0
Manganese	0.061	0
Iron	2.77	0
Nickel	0.073	0
Copper	2.25	0
Zinc	1.34	0
Arsenic	0.002	0
Selenium	0.003	0
Bromine	0.007	0
Rubidium	0.008	0
Strontium	0.026	0
Barium	0.31	0
Lead	0.18	0
Elemental Carbon	0.94	0
Organic Carbon	32.4	0
Magnesium	0.5	0
Sodium	0.05	0
Chlorine	0.09	0
Nitrates	0.38	0
Sulfates	0.39	0
Ammonium	0.019	0

VI.8 AIRS DATA

VI.8.1 Elemental Composition—Aldine-18 August

VI.8.2 Elemental Composition—Aldine-19 August

VI.8.3 Elemental Composition—Aldine-25 August

VI.8.4 Elemental Composition—Galveston-20 August

VI.8.5 Elemental Composition—Galveston-22 August

VI.8.6 Elemental Composition—Conroe-30 August

VI.8.7 Elemental Composition—HRM-3-5 September

VI.8.8 Elemental Composition—HRM-3-6 September

VI.8.9 Elemental Composition—HRM-3-7 September

VI.8.10 Elemental Composition—HRM-3-8 September

VI.8.11 Elemental Composition—HRM-3-13 September

VI.8.1 Elemental Composition—Aldine-18 August

	PM 2.5 (ug/m^3)	% OF TOTAL
CONSTITUENT		
Antimony	0.00555	0.02857
Arsenic	0.00334	0.01720
Aluminum	0.362	1.86368
Barium	0.0294	0.15136
Bromine	0.00273	0.01405
Copper	0.00311	0.01601
Cerium	0.00862	0.04438
Gallium	0.00057	0.00293
Iron	0.303	1.55993
Hafnium	0.0073	0.03758
Lead	0.00137	0.00705
Manganese	0.00617	0.03176
Molybdenum	0	0.00000
Nickel	0.00132	0.00680
Mercury	0.00085	0.00438
Gold	0	0.00000
Lanthanum	0.0111	0.05715
Niobium	0.00165	0.00849
Selenium	0.00033	0.00170
Tin	0.00909	0.04680
Titanium	0.0256	0.13180
Vanadium	0.00127	0.00654
Silicon	0.884	4.55108
Silver	0	0.00000
Zinc	0.0183	0.09421
Strontium	0	0.00000
Sulfur	2.17	11.17178
Tantalum	0.00532	0.02739
Terbium	0.00151	0.00777
Rubidium	0	0.00000
Potassium	0.159	0.81858
Yttrium	0.00052	0.00268
Zirconium	0.00193	0.00994
Ammonium	0.956	4.92176
K+	0.155	0.79798
Organic Carbon	4.6	23.68210
Total Nitrate	0.655	3.37213
Elemental Carbon	0.543	2.79552
Sulfate	8.49	43.70893
TOTAL	19.42395	100

VI.8.2 Elemental Composition—Aldine-19 August

	PM 2.5 (ug/m^3)	% OF TOTAL
CONSTITUENT		
Arsenic	0.00203	0.00768
Aluminum	0.0265	0.10027
Barium	0.0271	0.10254
Bromine	0.00235	0.00889
Cadmium	0.00075	0.00284
Copper	0.00174	0.00658
Cesium	0.00913	0.03455
Gallium	0.00057	0.00216
Iron	0.108	0.40865
Hafnium	5.00E-05	0.00019
Lead	0.00353	0.01336
Manganese	0.0041	0.01551
Iridium	0.00141	0.00534
Molybdenum	0.00071	0.00269
Nickel	0.00226	0.00855
Magnesium	0.0114	0.04314
Mercury	0.00052	0.00197
Selenium	0.00085	0.00322
Tin	0.00551	0.02085
Titanium	0.0088	0.03330
Vanadium	0.00226	0.00855
Silicon	0.264	0.99893
Silver	0.00273	0.01033
Zinc	0.0106	0.04011
Sulfur	3.58	13.54615
Tantalum	0.00636	0.02407
Potassium	0.0895	0.33865
Wolfram	0.00542	0.02051
Ammonium	2.95	11.16233
K+	0.161	0.60920
Organic Carbon	4.69	17.74621
Total Nitrate	0.41	1.55137
Elemental Carbon	0.339	1.28272
Sulfate	13.7	51.83861
TOTAL	26.42818	100

VI.8.3 Elemental Composition—Aldine-25 August

CONSTITUENT	PM 2.5 (ug/m^3)	% OF TOTAL
Arsenic	0.00151	0.01502
Barium	0.0226	0.22475
Bromine	0.00184	0.01830
Cadmium	0.0032	0.03182
Copper	0.0112	0.11138
Cerium	0.00014	0.00139
Iron	0.0638	0.63448
Lead	0.00758	0.07538
Indium	0.00057	0.00567
Manganese	0.00466	0.04634
Nickel	0.00123	0.01223
Magnesium	5.00E-05	0.00050
Lanthanum	0.0186	0.18497
Tin	0.00739	0.07349
Titanium	0.00151	0.01502
Vanadium	0.00132	0.01313
Silicon	0.057	0.56686
Silver	0.00184	0.01830
Zinc	0.0109	0.10840
Sulfur	0.913	9.07966
Potassium	0.0222	0.22078
Sodium	0.045	0.44752
Ammonium	0.419	4.16690
K+	0.0633	0.62951
Organic Carbon	3.77	37.49214
Total Nitrate	0.416	4.13706
Elemental Carbon	0.72	7.16030
Sulfate	3.47	34.50868
TOTAL	10.05544	100

VI.8.4 Elemental Composition—Galveston-20 August

CONSTITUENT	PM 2.5 (ug/m^3)	% OF TOTAL
Antimony	0.00414	0.02805
Arsenic	0.00019	0.00129
Aluminum	0.0199	0.13483
Barium	0.0273	0.18497
Bromine	0.00203	0.01375
Cadmium	0.00174	0.01179
Copper	0.00047	0.00318
Cerium	0.00753	0.05102
Cesium	0.0057	0.03862
Gallium	0.00198	0.01342
Iron	0.0432	0.29269
Lead	0.00217	0.01470
Indium	0.00057	0.00386
Manganese	0.00137	0.00928
Iridium	0.00235	0.01592
Molybdenum	0.00184	0.01247
Nickel	0.00099	0.00671
Mercury	0.00043	0.00291
Lanthanum	0.00099	0.00671
Niobium	0.00108	0.00732
Selenium	0.0009	0.00610
Tin	0.00843	0.05712
Titanium	0.00311	0.02107
Scandium	0.00019	0.00129
Vanadium	0.00278	0.01884
Silicon	0.144	0.97564
Zinc	0.00174	0.01179
Strontium	0.00014	0.00095
Sulfur	2.45	16.59946
Tantalum	0.0136	0.09214
Potassium	0.0473	0.32047
Yttrium	0.00085	0.00576
Sodium	0.0988	0.66940
Wolfram	0.00461	0.03123
Ammonium	1.75	11.85675
K+	0.0731	0.49527
Organic Carbon	1.67	11.31473
Total Nitrate	0.214	1.44991
Elemental Carbon	0.19	1.28730
Sulfate	7.96	53.93129
TOTAL	14.75952	100

VI.8.5 Elemental Composition—Galveston-22 August

	PM 2.5 (ug/m^3)	% OF TOTAL
CONSTITUENT		
Antimony	0.00014	0.00087
Aluminum	0.00085	0.00530
Barium	0.0273	0.17026
Bromine	0.00391	0.02438
Copper	0.00057	0.00355
Cerium	0.0056	0.03492
Cesium	0.00292	0.01821
Iron	0.0395	0.24634
Lead	0.0032	0.01996
Indium	0.0001	0.00062
Manganese	0.00028	0.00175
Molybdenum	0.00104	0.00649
Nickel	0.00066	0.00412
Gold	0.00085	0.00530
Lanthanum	0.0233	0.14531
Selenium	0.00099	0.00617
Tin	0.0104	0.06486
Titanium	0.00443	0.02763
Vanadium	0.00287	0.01790
Silicon	0.126	0.78580
Zinc	0.00141	0.00879
Sulfur	2.74	17.08809
Potassium	0.0685	0.42720
Sodium	0.0834	0.52013
Wolfram	0.00344	0.02145
Ammonium	1.74	10.85156
K+	0.0829	0.51701
Organic Carbon	2.54	15.84078
Total Nitrate	0.268	1.67139
Elemental Carbon	0.202	1.25978
Sulfate	8.05	50.20406
TOTAL	16.03456	100

VI.8.6 Elemental Composition—Conroe-30 August

	PM 2.5 (ug/m^3)	% OF TOTAL
CONSTITUENT		
Aluminum	0.00898	0.10768
Barium	0.0268	0.32136
Bromine	0.00329	0.03945
Cadmium	0.00211	0.02530
Calcium	0.0447	0.53600
Copper	0.00038	0.00456
Iron	0.0479	0.57437
Lead	0.00381	0.04569
Indium	0.00325	0.03897
Manganese	0.00155	0.01859
Nickel	0.00019	0.00228
Gold	0.00155	0.01859
Lanthanum	0.00019	0.00228
Tin	0.0047	0.05636
Titanium	0.00447	0.05360
Vanadium	0.00061	0.00731
Silicon	0.106	1.27104
Silver	0.00132	0.01583
Zinc	0.00301	0.03609
Strontium	0.00122	0.01463
Sulfur	1.26	15.10864
Rubidium	0.00132	0.01583
Potassium	0.049	0.58756
Yttrium	0.00075	0.00899
Sodium	0.1	1.19910
Ammonium	0.352	4.22083
K+	0.0625	0.74944
Organic Carbon	2.88	34.53403
Total Nitrate	0.286	3.42942
Elemental Carbon	0.182	2.18236
Sulfate	2.9	34.77385
TOTAL	8.3396	100

VI.8.7 Elemental Composition—HRM-3-5 September

CONSTITUENT	PM 2.5 (ug/m^3)	% OF TOTAL
Arsenic	0.00127	0.00509
Aluminum	0.0464	0.18582
Barium	0.0543	0.21746
Bromine	0.00575	0.02303
Copper	0.00207	0.00829
Chlorine	0.00099	0.00396
Cesium	0.0102	0.04085
Gallium	0.0009	0.00360
Iron	0.146	0.58470
Lead	0.00339	0.01358
Indium	0.00508	0.02034
Manganese	0.00528	0.02115
Nickel	0.00146	0.00585
Magnesium	0.0232	0.09291
Mercury	0.00179	0.00717
Lanthanum	0.0204	0.08170
Tin	0.00843	0.03376
Titanium	0.00428	0.01714
Vanadium	0.00184	0.00737
Silicon	0.272	1.08931
Zinc	0.0266	0.10653
Strontium	0.00085	0.00340
Sulfur	2.35	9.41130
Tantalum	0.0109	0.04365
Potassium	0.163	0.65278
Yttrium	0.00099	0.00396
Sodium	0.206	0.82499
Zirconium	0.0016	0.00641
Ammonium	2.44	9.77174
K+	0.148	0.59271
Organic Carbon	9.26	37.08455
Total Nitrate	0.267	1.06928
Elemental Carbon	1.22	4.88587
Sulfate	8.26	33.07974
TOTAL	24.96997	100

VI.8.8 Elemental Composition—HRM-3-6 September

CONSTITUENT	PM 2.5 (ug/m^3)	% OF TOTAL
Arsenic	0.00038	0.00102
Barium	0.0333	0.08936
Bromine	0.0049	0.01315
Copper	0.00123	0.00330
Cesium	0.00344	0.00923
Gallium	0.00179	0.00480
Iron	0.0483	0.12961
Lead	0.00245	0.00657
Manganese	0.00085	0.00228
Iridium	0.00325	0.00872
Nickel	0.00179	0.00480
Magnesium	0.00386	0.01036
Niobium	0.00085	0.00228
Selenium	0.00127	0.00341
Tin	0.00866	0.02324
Titanium	0.00377	0.01012
Vanadium	0.00353	0.00947
Silicon	0.123	0.33005
Silver	0.00019	0.00051
Zinc	0.0126	0.03381
Sulfur	4.06	10.89442
Tantalum	0.0148	0.03971
Potassium	0.157	0.42129
Sodium	0.126	0.33810
Wolfram	0.00758	0.02034
Ammonium	5.19	13.92661
K+	0.135	0.36225
Organic Carbon	12	32.20025
Total Nitrate	0.285	0.76476
Elemental Carbon	0.832	2.23255
Sulfate	14.2	38.10363
TOTAL	37.26679	100

VI.8.9 Elemental Composition—HRM-3-7 September

CONSTITUENT	PM 2.5 (ug/m^3)	% OF TOTAL
Aluminum	0.00043	0.00320
Barium	0.0186	0.13858
Bromine	0.00301	0.02243
Copper	0.00254	0.01892
Cerium	0.00904	0.06735
Gallium	0.00179	0.01334
Iron	0.0288	0.21457
Hafnium	0.00428	0.03189
Lead	0.00405	0.03017
Manganese	0.0016	0.01192
Iridium	0.00268	0.01997
Nickel	0.0009	0.00671
Lanthanum	0.0178	0.13262
Niobium	0.00207	0.01542
Selenium	0.0016	0.01192
Tin	0.00386	0.02876
Titanium	0.00137	0.01021
Vanadium	0.00221	0.01647
Silicon	0.0527	0.39263
Silver	0.00217	0.01617
Zinc	0.00395	0.02943
Sulfur	1.38	10.28140
Tantalum	0.0125	0.09313
Rubidium	5.00E-05	0.00037
Potassium	0.0835	0.62210
Sodium	0.0927	0.69064
Ammonium	0.941	7.01072
K+	0.0821	0.61167
Organic Carbon	6.1	45.44676
Total Nitrate	0.279	2.07863
Elemental Carbon	0.476	3.54634
Sulfate	3.81	28.38560
TOTAL	13.4223	100

VI.8.10 Elemental Composition—HRM-3-8 September

	PM 2.5 (ug/m^3)	% OF TOTAL
CONSTITUENT		
Antimony	0.00263	0.02210
Aluminum	0.00047	0.00395
Barium	0.0262	0.22015
Bromine	0.00164	0.01378
Copper	0.0008	0.00672
Cerium	0.0128	0.10756
Cesium	0.00164	0.01378
Gallium	0.00023	0.00193
Iron	0.0292	0.24536
Lead	0.00258	0.02168
Manganese	0.00206	0.01731
Nickel	0.0001	0.00084
Lanthanum	0.00942	0.07915
Tin	0.0113	0.09495
Titanium	0.00249	0.02092
Scandium	0.00019	0.00160
Vanadium	0.00089	0.00748
Silicon	0.0466	0.39157
Zinc	0.00497	0.04176
Sulfur	1.36	11.42773
Tantalum	0.00694	0.05832
Rubidium	0.00019	0.00160
Potassium	0.0369	0.31006
Sodium	0.0884	0.74280
Wolfram	0.00624	0.05243
Ammonium	1.02	8.57079
Organic Carbon	3.89	32.68666
Total Nitrate	0.268	2.25193
Elemental Carbon	0.278	2.33596
Sulfate	4.79	40.24912
TOTAL	11.90088	100

VI.8.11 Elemental Composition—HRM-3-13 September

CONSTITUENT	PM 2.5 (ug/m^3)	% OF TOTAL
Arsenic	0.00145	0.01580
Barium	0.026	0.28324
Bromine	0.00042	0.00458
Copper	0.00098	0.01068
Chlorine	0.00352	0.03835
Cerium	0.0233	0.25383
Gallium	0.00141	0.01536
Iron	0.0546	0.59481
Hafnium	0.00478	0.05207
Lead	0.00244	0.02658
Indium	0.00071	0.00773
Manganese	0.00432	0.04706
Iridium	0.00117	0.01275
Nickel	0.00333	0.03628
Magnesium	0.00164	0.01787
Mercury	0.00094	0.01024
Lanthanum	0.00567	0.06177
Niobium	0.00066	0.00719
Selenium	0.00042	0.00458
Tin	0.00839	0.09140
Titanium	0.00281	0.03061
Vanadium	0.00933	0.10164
Silicon	0.0651	0.70920
Zinc	0.0083	0.09042
Strontium	0.0001	0.00109
Sulfur	0.804	8.75875
Tantalum	0.0121	0.13182
Potassium	0.0175	0.19064
Sodium	0.166	1.80840
Ammonium	0.582	6.34029
Organic Carbon	2.88	31.37463
Total Nitrate	0.283	3.08299
Elemental Carbon	0.723	7.87634
Sulfate	3.48	37.91102
TOTAL	9.17939	100

BIBLIOGRAPHY

Arya, S.P. (1999), Air Pollution Meteorology and Dispersion, Oxford University Press, Inc., New York, NY, 8-12.

Chow, J.C., et al (2001), Comparison of IMPROVE and NIOSH carbon measurements, *Aerosol Science and Technology* 34, 23-34.

Fehsenfeld, F., et al (1992), Emissions of volatile organic compounds from vegetation and the implications for atmospheric chemistry, *Global Biochemistry Cycles* 6 (4), 389-430.

Graedel, T.E. (1978), Chemical Compounds in the Atmosphere, Academic Press, New York, NY.

Guenther, A., et al (2000), Natural emissions of non-methane volatile organic compounds, carbon monoxide, and oxides of nitrogen from North America, *Atmospheric Environment* 34, 2205-2230.

Kamens, R.M (1999), Newly characterized products and composition of secondary aerosols from the reaction of α-pinene with ozone, *Atmospheric Environment* 33, 459-474.

Klinedinst, D.B. (1999), Direct quantification of PM2.5 fossil and biomass carbon within the Northern Front Range Air Quality Study's domain, *Environmental Science and Technology* 33, 4146-4154.

Klouda, G.A. (1999), Isotopic (^{14}C) and chemical composition of atmospheric volatile organic compound fractions—precursors to ozone formation, Proceedings of the 3rd International Conference on Isotopes, 289-293.

Lonneman, W.A (2000), Standard operating procedure for the cryogen gas chromatographic-flame ionization detection (cryoGC-FID) system, U.S. Environmental Protection Agency.

Manahan, S.E. (1991), Environmental Chemistry, 5th edition, Lewis Publishers, Inc., Chelsea, MI, 295-296.

Seinfeld, J.H. (1986), Atmospheric Chemistry and Physics of Air Pollution, Wiley-Interscience, New York, NY.

Stiles, D.C. (2000), Texas 2000: VOC and particulate sample collection for radiocarbon analysis, TR-4425-00-03, ManTech Environmental Technology, Inc.

Urone, P. (1986), The Pollutants, *Air Pollution*, 3rd edition, Volume VI (A.C. Stern, ed.), Academic Press, New York, NY, 1-59.

U.S. Environmental Protection Agency (1982), Air quality criteria for particulate matter and sulfur oxides, Report No. EPA-600/8-82-029, U.S. Environmental Protection Agency.

VITA

Kenneth Robert Lemire was born in Claremont, New Hampshire on 12 June 1971, the son of Donald Robert Lemire and Mary Bondville Lemire. After completing his work at Stevens High School, Claremont, New Hampshire, in 1989, he entered the United States Military Academy at West Point, New York. He received the degree of Bachelor of Science from West Point on 29 May 1993 and was commissioned as a second lieutenant in the United States Army. He then served six years in the U.S. Army as a Tank Platoon Leader, Tank Company Executive Officer, Armored Cavalry Squadron S-4, Doctrine Writer, and Basic Training Company Commander while being promoted to first lieutenant in 1995 and then captain in 1997. In June, 1999, he entered The Graduate School of The University of Texas.

Permanent Address: 364 Sycamore Circle
Lebanon Junction, Kentucky 40150

This thesis was typed by the author.